ALEUTIAN ISLANDS HOUSING AUTHORITY TRIP REPORT:

ST. PAUL ISLAND, FALSE PASS AND KING COVE

Assessment of Mold and Moisture Conditions

Final Report

Date:
August 16-20, 2004

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Office of Native American Programs

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TABLE OF CONTENTS

PART I

ALEUTIAN ISLAND HOUSING AUTHORITY TRIP REPORT:
ST. PAUL, FALSE PASS, KING COVE

INTRODUCTION

Paul Francisco, Building Research Council (BRC) at the University of Illinois Urbana-Champaign and Robert Nemeth, Magna Systems, Inc. conducted a combined site visit to the St. Paul, False Pass, and King Cove Communities on August 16-20, 2004. The Aleutian Island Housing Authority (AIHA) administers the housing program for the Aleutian and Pribilof Communities. The site visit provided technical assistance to AIHA in assessing mold and moisture conditions in housing units. This report summarizes the activities and issues addressed. A detailed analysis of findings and recommendations is found in *PART II: Aleutian Island Housing Authority (St. Paul Island, False Pass, and King Cove) Technical Housing Assessment Report: Examining Mold and Moisture Conditions of Homes for the Aleutian and Pribilof Communities.*

BACKGROUND INFORMATION

ST. PAUL

St. Paul is a village located on a narrow peninsula on the southern tip of St. Paul Island, the largest of the five islands making up the Pribilof Island group. St. Paul is 750 miles west of Anchorage, 240 miles north of the Aleutian Island chain and 300 miles west of the mainland of Alaska. St. Paul is just over 40 square miles in size. It has an Arctic maritime climate with cool weather year round and a range of temperatures from 19 to 51 degrees. It has an average annual rainfall of 25 inches and 56 inches of snow. Approximately 504 Aleut and 259 Non-native persons live on the island. AIHA manages a total of 177 housing units, of which 105 were owner occupied, 49 were renter occupied, and 23 were vacant, with an average of 3.6 persons per home. Ninety-six percent of the homes relied on fuel oil or kerosene for heating and six percent heated with electricity.

FALSE PASS

False Pass, a village located in Aleutians East Borough, Alaska, lies on the eastern shore of Unimak Island on a strait connecting the Gulf of Alaska with the Bering Sea. The name is derived from the fact that the Bering Sea side of the strait is very shallow and cannot accommodate large vessels. False Pass was originally settled by a homesteader in the early 1900s, and grew with the establishment of a cannery in 1917. The community of False Pass is primarily Aleut. Subsistence activities are a mainstay of the lifestyle. False Pass is an important stop for Bristol Bay and Bering Sea fishing fleets. As of the 2000 census, the population of was 64. There were 22 homes, and 13 families residing in the village. There were 40 housing units.

KING COVE

Located in Aleutians East Borough, Alaska, the Village of King Cove was founded in 1911 when Pacific American Fisheries built a salmon cannery there. The town sits on the south side of the Alaska Peninsula on a sand spit fronting Deer Island and Deer Passage. King Cove's economy depends almost entirely on the year-round commercial fishing and fish processing industries. There is a deepwater dock that provides moorage for 90 boats. King Cove is accessible only by sea or air. As of the 2000 census, the population of the village was 792. There were 207 housing units, 170 of which were occupied. Of the occupied units, 103 were owner-occupied and 67 were renter-occupied.

Day 1: Monday: August 16, 2004

Travel day to Alaska.

Day 2: Tuesday: August 17, 2004

Travel to St. Paul Island

Day 3: Wednesday: August 18, 2004

On Wednesday morning, the assessment team met with David Vought, HUD Alaska ONAP office; Douglas MacArthur, Aleutian Housing Authority; Pat Baker, Tribal Government of St. Paul; Andy Conception, HUD Alaska ONAP; Richard Zacharof, Tribal Government of St. Paul; John Davies, Cold Climate Housing Research Center (CCHRC) in Fairbanks, Alaska; and Cindy Bourdukofsky, Tribal Government of St. Paul, to discuss housing problems on St. Paul Island. Funding concerns took precedence over the discussion of mold issues.

Four homes were inspected and digital photographs were taken to record conditions. The inspection process involved visual assessments of both interior and exterior conditions. The team returned to Anchorage.

Day 4: Thursday: August 19, 2004

On Thursday morning Paul Francisco, Robert Nemeth, David Vought, Douglas MacArthur, and John Davies traveled from Anchorage to False Pass. Two homes were inspected in False Pass before flying to King Cove where the team inspected three homes. The team stayed overnight in King Cove.

Day 5: Friday: August 20, 2004

The assessment team inspected one home in the morning before flying back to Cold Bay and then Anchorage. Paul Francisco returned to Illinois and Robert Nemeth to Juneau.

FINDINGS

An overview of findings and recommendations for the site visit follows. *PART II: Aleutian Islands (St. Paul, False Pass, and King Cove) Housing Authority Technical Housing Assessment Report: Examining Mold and Moisture Conditions of Homes in the Aleutian and Pribilof Communities* provides a detailed analysis of findings and recommendations for the homes investigated.

ST. PAUL

1. In the four inspected St. Paul homes mold ranged from minor to significant.
2. None of the inspected home had gutters or downspouts. Drip lines were visible around the perimeters of the homes. The area's strong winds drive rain nearly horizontal, so gutters will do little to keep the homes and the perimeter ground dry. However, gutter systems would reduce the amount of water near the foundation by directing the rain that falls on the roof away from the home. In these homes, gutter systems can be considered luxuries that can provide some benefit but less than in most locations.
3. All three accessed crawl spaces were wet. This was due to poor site drainage and the poor management of rainwater from roof surfaces.
4. The longitudinal marriage joint between the modular units often leaked or had condensation problems at the ceiling.
5. Plumbing problems existed in three of the four homes and one home had an inoperable bath fan.
6. All range hoods had recirculating fans that exhausted to the interior.
7. Combustion air intake was drawn from the attic space via a grille located high on an interior wall of the mechanical room. This grille led to a stud cavity that extended into the attic and was capped by fine wire mesh. This combustion air strategy also worked in reverse, allowing warm moist air to migrate into the attic space. Marginal attic ventilation coupled with moisture in the attic space has resulted in mold growth on attic sheathing.
8. Dealing with the area's strong winds made attic ventilation marginal. Venting was accomplished via a chase constructed on the exterior of the home and located on the upper two-thirds (approximately) of the home's height rather than gable-end grilles, ridge vents, or soffit vents. This chase, similar to an inverted chimney, led to a gable-end grille. The chase effectively protected the attic from wind-driven rain that would have entered through the gable-end grille; however, it also can significantly reduce attic ventilation and make it possible for occupants to close off the vent entry.
9. Thermal bridges at window jambs, at exterior corners and at the marriage joint were common locations for mold growth.
10. Occupant lifestyles also contributed to moisture and other indoor air quality (IAQ) issues. Lifestyle issues included clutter inside and around the perimeter of the home, in the crawl space beneath the home and in the attic.

FALSE PASS

1. Neither home had gutters or downspouts. The area's strong winds drive rain nearly horizontal, so gutters will do little to keep the homes and the perimeter ground dry; however, gutter systems would reduce the amount of water near the pier foundations by directing the rain that falls on the roof away from the home. In these homes, gutter systems can be considered luxuries that can provide some benefit but less than in most locations. Additionally, the grade surrounding the houses was flat making drainage away from the structure a problem.
2. The crawl spaces beneath the homes were wet and filled with clutter.
3. Plumbing leaks were evident in both inspected homes. Kitchen sink leaks in one unit contributed to mold in the cabinet and its deterioration.
4. Both homes had recirculating range hoods.
5. In the one inspected attic, the underside of the roof sheathing had some mold growth.

KING COVE

1. Each of the four inspected homes had mold growth.
2. None of the homes had gutters or downspouts. The area's strong winds drive rain nearly horizontal, so gutters will do little to keep the homes and the perimeter ground dry; however, gutter systems would reduce the amount of water near the foundation by directing the rain that falls on the roof away from the home. In these homes resting on piers, gutter systems can be considered luxuries that can provide some benefit but less than in most locations.
3. Air and water had infiltrated the wall and floor systems. Causes include:
   - Loose siding and flashing.
   - Gaps in seams between flashing.
   - The air barriers under the siding.
   - Porches that recessed into the home. These recessed porches allowed wind-driven rain to collect at the base of the exterior at the floor of the occupied space.
4. Two boiler flues were missing chimney caps, allowing water to infiltrate the flue.
5. Three homes had recirculating range hoods and the fourth unit was missing its range hood.
6. Two homes had plumbing problems resulting in mold and damage.
7. Mold was on the interior due to thermal bridges through the envelope.

RECOMMENDATIONS

Recommendations relating to the technical issues are summarized below. For more detailed discussion, see the *Technical Housing Assessment Report* for additional information.

1. Although site drainage for homes resting on piers is not as critical as for homes with conventional crawl space or basement foundations, it is still undesirable to have a moist environment directly beneath the home. Efforts should focus on diverting rainwater/snow melt away from the foundation through proper grading of the surrounding site.

2. Install gutters, downspouts, leaders and splashblocks to drain water away from the homes. Moving this water away from the home will reduce the problems. Given the preponderance of wind-driven rain, gutters will be less effective than at other geographical locations.

3. Keep clutter out of the crawl space to reduce the mold beneath the home.

4. Large amounts of moisture generated in bathrooms and kitchens can be removed by properly operating exhaust fans. Fans should exhaust all the way to outside rather than into spaces such as attics. Recirculating kitchen range hoods do not provide ventilation and therefore do not remove moisture from the home.

5. The assessment team identified a number of maintenance items that impact moisture and other IAQ problems. Plumbing leaks were prevalent and should receive priority.

6. Combustion air was usually drawn from the attic. The direct link between the mechanical room and the attic allowed moist air from the mechanical room and laundry into the attic. Installing ducting to bring the combustion air from outside will eliminate the minor mold problems found on the roof sheathing.

7. Several building envelopes allowed air and water infiltration into wall and floor systems leading to structural deterioration. Due to the unique weather conditions, such as recurring horizontal precipitation, detailing and construction of the envelope requires extensive care.

8. Mold was on the insulation dam at the attic hatch. Though all the inspected hatches were insulated, they were not air sealed with suitable weatherstripping.

9. Occupant cooperation is essential to minimize moisture and other IAQ problems.

10. Remediation plans should first resolve mold source problems and ensure remediation efforts are performed properly.

Programmatic Recommendations:

Local organizations responsible for housing should develop a service-delivery system to effectively address mold and moisture conditions. This would include training for the maintenance staff on how to implement the technical recommendations, and training for residents on their roles and responsibilities as renters and homeowners. Some strategies are:

1. As part of the annual recertification process, require attendance at annual homeowner/renter clinics. These clinics will provide instruction on home maintenance issues. Topics such as identifying and repairing leaks could be presented.
2. During the annual recertification process, ask occupants to fill-out a survey based on Housing Quality Standards (HQS) along with some additional questions on mold and moisture conditions in their homes. Having the resident complete the survey, it further engages the occupants in their home maintenance. The survey responses will provide additional information to the housing authority on any unreported problems (especially leaks and inoperable fans) that may contribute to an unsafe, unhealthy home environment.

MOLD TESTING

The assessment team maintains that if there is mold inside a building, it should be cleaned up. Generally, identifying the species of mold growing in a residence was unnecessary. No baseline exists for acceptable or unacceptable mold concentrations in a home. This message concurs with other federal agencies and experts as documented below. *Attachment 1* is a copy of *The Measurement Problem Regarding Mold.*

The Bemidji Area Indian Health Service Office of Environmental Health and Engineering, Environmental Health Services Section (BAIHS EHSS*), Guidelines on Assessment and Remediation of Fungi in Indoor Environments,* takes this position on testing:

> Consistent with the Center for Disease Control (CDC) and Environmental Protection Agency, BAIHS EHSS does not recommend testing as the first response to an indoor air quality concern. Instead, careful detailed visual inspection and recognition of moldy odors should be used to find problems needing correction. Efforts should focus on areas where there are signs of moisture or high humidity or where moisture problems are suspected. The investigation goals should be to locate indoor mold growth to determine how to correct the moisture problem and remove contamination safely and effectively.

The Adverse Human Health Effects Associated with Molds in the Indoor Environment by the American College of Occupational and Environmental Medicine, states that to successfully remediate mold and moisture conditions, the water and moisture sources must be identified and corrected.

> Mold spores are present in all indoor environments and cannot be eliminated from them. Normal building materials and furnishing provide ample nutrition for many species of molds, but they can grow and amplify indoors only when there is an adequate supply of moisture. Where mold grows indoors, there is an inappropriate source of water and moisture that must be identified and corrected before remediation of the mold colonization can succeed. Mold growth in the home, school, or office environment should not be tolerated because mold physically destroys the building materials on which it grows, mold growth is unsightly and may produce offensive odors and mold is likely to sensitize and produce allergic responses in allergic individuals. Except for persons with severely impaired immune systems, indoor mold is not a source of fungal infections. Current scientific evidence does not support the proposition that human health has been adversely affected by inhaled mycotoxins in home, school, or office environment.

BAIHS EHSS Guidelines on Assessment and Remediation of Fungi in Indoor Environments discusses the limitations of testing as follows:

> Mold testing only provides a snap-shot estimate for a single point in time and a single location. How well the test represents other locations and times is uncertain since the amounts and types of mold in the environment are always changing. Furthermore, there is no basis for setting a baseline of acceptable or unacceptable mold concentrations. The variability can be especially large for airborne molds, with significant changes occurring over the course of hours or less. Caution must also be used in interpreting surface testing results, since mold growth or deposition may not be uniform over an area and may increase or decrease as time passes. Unless many samples are taken over a period of time and the investigator has been mindful of building operations and activities during the testing, the results might not be very representative of typical conditions; in addition, tests reflecting typical conditions may also miss evidence of problems that only occur infrequently (water leaks during rain storms).

Mold testing is often expensive. Dollars spent on unnecessary or poorly done testing, reduces the amount of money available for remediation and repairs. The following web-sites and references provide further information on mold remediation and testing:

Indoor Air Quality

> **Ball State University Indoor Environment Notebook** - General resource on a number of topics related to indoor air quality.
> http://publish.bsu.edu/ien/archives/archive_list.htm *(will open a new browser window)*

Mold

EPA - Mold Remediation in Schools and Commercial Buildings
http://www.epa.gov/iaq/molds/index.html *(will open a new browser window)*

New York City Department of Health Bureau of Environmental & Occupational Disease Epidemiology - Guidelines on Assessment and Remediation of Fungi in Indoor Environments
http://www.ci.nyc.ny.us/html/doh/html/epi/moldrpt1.html *(will open a new browser window*

References

Bemidji Area Indian Health Service Office of Environmental Health and Engineering, Environmental Health Services Section, *Guidelines on Assessment and Remediation of Fungi in Indoor Environments*

The Measurement Problem Regarding Mold, by William B. Rose, Research Architect, Building Research Council/School of Architecture, University of Illinois, Urbana-Champaign Campus, 2003.

Adverse Human Health Effects Associated with Mold in the Indoor Environment: Position Statement by Hardin, Kelman, and Saxon, American College of Occupational and Environmental Medicine, 2002.

Attachment 1

APPENDIX C: LIMITATIONS OF MOLD SAMPLING

The Measurement Problem Regarding Mold
By William B. Rose, Research Architect
Building Research Council/School of Architecture
University of Illinois, Urbana-Champaign

When complaints of mold problems occur, two courses of action are appropriate: 1) visually assess the site, remove the mold, and correct the conditions that led to the mold and 2) contact health professionals for allergy or respiratory problems. The proper action is to discover sites of mold growth. Where this approach has been used, the outcome has been, in every case, improvement of indoor environment conditions (though the improvements may take time) and improvement of health conditions. This is the recommended approach for dealing with mold problems in housing in Indian areas.

Techniques for sampling biological aerosols were developed for industrial and agricultural settings. They were designed to help industrial hygienists determine the safety of workplaces and other environments. The value of their work was evident in determining the causes of the Legionella outbreak of 20 years ago, and in sampling for biological warfare agents at present. Sampling produces counts of mold material from samples taken in the air or on surfaces. It may determine the number of viable spores in a sample from the air or a surface. And it may be used to identify genus and species of mold found in the sample.

Neither of the two recognized guidelines for mold remediation, the NYC Department of Health's *Guidelines on Assessment and Remediation of Fungi in Indoor Environments* and the USEPA's *Mold Remediation in Schools and Commercial Buildings*, calls for environmental sampling for routine mold problems. Both guidelines discourage environmental sampling in most cases. This opinion is summarized on the CDC website:

> Generally, it is not necessary to identify the species of mold growing in a residence, and CDC does not recommend routine sampling for molds. Current evidence indicates that allergies are the type of diseases most often associated with molds. Since the susceptibility of individuals can vary greatly either because of the amount or type of mold, sampling and culturing are not reliable in determining health risk . . . reliable sampling for mold can be expensive, and standards for judging what is and what is not an acceptable or tolerable quantity of mold have not been established.

In general, the use of mold sampling must be discouraged. There are several reasons for this. First, aside from allergic effects, the health outcomes of mold in homes, schools or offices have not been established. Second, given those circumstances, there is no basis for setting a baseline of acceptable or unacceptable mold concentrations. Third, the internal repeatability of mold sampling results has not been shown in the literature. Fourth, weaknesses in the visual assessment protocols have not been demonstrated.

Mold sampling has been done in residential settings, leading to conclusions about the presence of mold, about the presence of individual species of mold, and about high concentrations of mold in some locations. However, much of the information provided by sampling is already known from common sense. The following are some facts about mold in indoor environments that are known even before measurements are taken:

1. Mold is everywhere. The outdoor air contains rather high concentrations of mold spores, which are naturally occurring. By contrast, most building interiors contain lower concentrations, though the concentrations indoors and outdoors vary over time. Indoor air comes from the outdoors. If the indoor is cleaner than the outdoors, something served as a filter, accumulating mold, dust and airborne material over time. Some commercial buildings have filtration systems designed to clean air as it passes from outdoors to indoors. But in most buildings, the outdoor air infiltrates through cracks and cavities in the building envelope as it travels indoors. If the indoor air is cleaner, then the building envelope acts like a filter. Therefore, when a sample of indoor air is taken, mold spores will be found. The conclusion "This building has mold" can be made of all buildings.

2. Dust, dirt, mold spores and other particulates accumulate in building cavities over time. There is no passive cleaning process for building cavities to match this cumulative process. Because the walls and roofs filter outdoor air as it moves indoors, all building cavities must be considered as sites with high concentrations of mold spores and other airborne material.

3. Evidence indicates that where proper conditions are in place, sooner or later the species that typically inhabit such spaces will arrive. *Stachybotrys* is known to inhabit pulpy cellulose materials that are maintained at a high water activity level. With the right quantity of water, the paper facing of gypsum products generally shows the growth of *Stachybotrys*. Where the appropriate conditions are maintained for a long enough time, *Stachbotrys* and other species appear and grow. "Wet it, and they will come."

4. It is logically impossible to prove a negative statement. There are no tests that allow one to draw the conclusion that absolutely no mold spores representing a species are to be found in a space. Even if a test should turn up no spores of a given species that does not provide conclusive evidence of the total absence of that species from the interior space. And conditions may change from one hour to another. So a finding in a room or building of any given species, including *Stachybotrys*, should not be considered exceptional. The absence of a species from a space can be determined statistically to a pre-selected degree of confidence, requiring several tests.

What, then, remains to be discovered through mold measurement? It is already determined, for all buildings, that mold is contained in the air, that any species may be found in the air or on the surface, and that high concentrations of mold are contained in the cavity. If a tenant or occupant complains about living conditions, it is clear that any unit that occupant will move to will have mold in the air, will have all common species of mold in the air or on surfaces, and will have high concentrations of mold in the building cavities. It is wrong to presume that buildings are sterile simply by virtue of their never having been measured.

Measurements of mold are not useful if the purpose of the measurement is to determine any or all of the following:

1) if the building has mold,
2) if a certain species, say, *Stachybotrys*, is present, or
3) if the building cavities have high concentrations

For the measurement criteria above, no measurements should be made, as the results will be dismissed as being of no use.

Possible Occasions for Mold Measurement

After the effective implementation of visual assessment and remediation of mold as described above and conditions of mold are suspected to still exist, it is possible (though unlikely) that a visual assessment will overlook a cause of distress. If that happens, one strong possibility is that the distress is not related to mold in the first place. However, in the case where a mold problem has not been accurately identified and remediated through visual assessment, three scenarios are often suggested as possible occasions for mold measurement:

1. Active mold growth is usually accompanied by amplification, the strong increase in mold of one or two species out of proportion to the background taxa.

2. Mold may have an odd source, such as air conditioning ductwork, and may be present in the building only when that source contributes to the space, or

3. An investigator may use a fixed level as a measure of acceptability or cleanliness (though it bears repetition: there are not exposure limits set by any authorities).

In each of these cases, mold measurement may be able to provide some insight.

The statistics of mold measurement

For mold measurement to provide insight, or to provide material for decision-making, the results of mold testing must be statistically significant. One measurement is never statistically significant. Understanding the notion of statistical significance requires understanding error and bias.

Two samples of the same space will never provide the same results. There is always some spread (or precision error) in the data. The mold sampling industry generally fails to make public their estimates of the precision error in their sampling methods. It would be good to know, for the same equipment, same operator, same laboratory, same technician, what the estimate of the error would be. That information is not presently available. In addition to precision error, there are many other factors that tend to bias the results one way or another. These include the following:

1. Time of the day (ascomycetes tend to release spores in the afternoon, basidiomycetes in the morning)
2. Season (lower during winter)
3. Snow cover (greatly reduces outdoor concentrations)
4. Sampling technique (lowest with culturable samples, medium with impactors, highest with PCR)
5. Variations over space (highest, usually, in basements and crawl spaces)
6. Variations by surface (highest near carpets)
7. Disturbance (greatly higher with scuffing and fluffing of carpets, etc.)
8. Variations by wetness (higher concentrations on wetter materials)
9. Laboratory
10. Technician

It is evident that achieving statistically significant results requires considerable care, in addition to thoroughly accounting for variables. All proposals for mold study that involve sampling must contain information that describes:

1. The yardstick, or baseline values, that will be used for interpretation,
2. The variables that are accounted for in the study,
3. The error estimate associated with those variables,
4. The confidence interval to be used (95% confidence in the results is recommended),
5. How the study will deliver that level of confidence.

Sampling campaigns that give numbers without giving statistical significance to those numbers are worse than worthless. They come at a financial and social cost and are very disruptive to the lives of individuals, families and tribes.

The range of concentrations often found in mold measurements is several orders of magnitude—sometimes several dozen spores or colony-forming-units (CFUs) per unit of mass or volume out to several million. Most guidance advises representing the distribution as lognormal; that is, if the data values are represented not as numbers with zeroes but as powers of ten, then the exponents occur in a normal distribution. This is quite helpful, as one of the tails of the distribution never drops below zero.

Let us presume that an environmental consultant hypothesizes that the airborne mold spore concentration in a room exceeds a certain value. Of course, the consultant would be obliged to cite the reference for the value selected. Taking a single sample gives a distinct reading for the sample but says nothing about the concentration in the room. A second sample, with a result different from the first, proves that a single sample cannot characterize the actual concentration. Also, clearly, the more samples that are taken, the more sure one can be that the mean of the measured values represents the actual value, and can be used in this comparison test.

Let us also presume that the confidence interval used is 0.05 ($\alpha = 0.05$). That means that 5% of the time the confidence in the veracity of the finding will be misguided. Nevertheless, many scientific and management findings use a 0.05 confidence interval. Tribal leaders or others who are entertaining proposals from environmental consultants might consider having a stated confidence interval at the time of the work proposal, perhaps of 5%.

Then standard statistics allows us to calculate the confidence interval. The result is usually expressed as a value $y \pm z$ ($\alpha = 0.05$). The value y is the mean (average) of the sample values. The value z is composed of the Standard Error (SE, equal to the standard deviation divided by square root of the count-1) times a factor called "student's-t" (t). This factor is commonly used in statistics when the number of samples is small; it is found in textbooks of statistics and as a common spreadsheet function. The value z is equal to (t) * (SE).

An environmental consultant may wish to sample to determine if a certain species is present or not. Common species of mold should always be deemed to be present, but may be proved to be absent, if indeed they are absent, to any selected degree of confidence (never for certain).

Testing is expensive. So there is a strong tendency on the part of both consultants and clients to conduct testing without regard to the statistical significance. This practice should end, as the results cannot be used for decision-making. If testing is to be done at all, then the testing campaign must be designed to have the power to provide answers to the critical questions.

All mold testing must include a minimum of two samples per measurement site. Taking only one sample leaves the impression that the value is somehow elevated above error. With two samples per site, the issue of error is inescapable. In addition all mold testing should:

- State the question or hypothesis that is being answered or addressed through testing
- State the criteria (absolute or comparison) used to address the hypothesis
- State the proposed confidence level.
- List the errors and biases that are accounted for (or controlled for) in the testing.
- Calculate the margin of error.
- Report the findings with the margin of error.
- Attach statistical significance to the conclusions.

July, 2003

PART II

ALEUTIAN ISLANDS (ST. PAUL ISLAND, FALSE PASS AND KING COVE)

HOUSING AUTHORITY TECHNICAL HOUSING ASSESSMENT REPORT

EXAMINING MOLD AND MOISTURE CONDITIONS IN HOMES IN THE ALEUTIAN ISLANDS

EXECUTIVE SUMMARY

The site assessment team inspected a total of ten homes for moisture and mold conditions in St. Paul, False Pass and King Cove. The principal findings include:

1. No inspected homes had a gutter system to manage rainwater. Due to ice, snow and wind conditions, gutters do not wear well in these areas. As a result, uncontrolled rainwater sheds off the roof. Fortunately, the two long sides of the homes do have roof overhangs that help shed water away from the home.

2. All the homes were situated on top of piers approximately three to four feet above grade. The areas beneath the homes were skirted, but the skirting was not airtight. Although most of these areas below the structures were wet, they were also isolated from the interiors of the homes.

3. The thermal envelope for the base of the structure was the floor system. In several instances the belly board beneath the floor joists' was violated and the insulation was missing, exposing the bottom of the plywood floor sheathing.

4. Six homes had plumbing problems, such as leaky vanities and kitchen sinks that caused major cabinet deterioration and contributed to mold problems.

5. Several homes had poor or inoperable bathroom exhaust ventilation systems which can result in significant interior moisture loads increasing the potential for mold growth.

6. Most kitchen exhaust fans were recirculating, which do not remove the substantial moisture generated while cooking.

7. The boilers and hot water heaters drew combustion air from the attic. The direct link between the mechanical room and the attic allowed moist air from the mechanical room and laundry into the attic. This has led to minor mold problems on roof sheathing.

8. Thermal bridges at corners, window jambs and at the wall to roof junction resulted in cold spots where high humidity or condensation occurred resulting in mold growth.

9. Wind driven water infiltration around loose siding and flashing has resulted in structural deterioration of floor sheathing and band joists.

This report provides technical recommendations and discussions focusing on these items. Appendix A includes a summary of findings from the inspections. Appendix B provides a detailed assessment of each home.

INTRODUCTION

Paul Francisco, Building Research Council (BRC) at the University of Illinois Urbana-Champaign, and Robert Nemeth, Magna Systems, Inc., conducted combined site visits to the St. Paul, False Pass, and King Cove Communities on August 16-20, 2004. The Aleutian Islands Housing Authority (AIHA) administers the housing program for the Aleutian and Pribilof Communities. The site visit provided technical assistance to AIHA in assessing mold and moisture conditions in housing units. This report details findings and recommendations for homes in St. Paul, False Pass and King Cove.

The assessment team investigated four homes in St. Paul, two in False Pass and four in King Cove. The homes examined were one-story modular homes resting on piers. The primary sources of heat were oil-fired boilers with hydronic heat, except for one home that had a forced-air oil-fired furnace.

The homes ranged in age from approximately fourteen years to thirty-one years old. All the homes lacked gutter systems to manage rainwater.

SECTION 1 - METHODOLOGY

Visual Inspection

Housing inspections consisted primarily of visual assessment of mold and moisture conditions. The assessment team used forms developed for the Chicago Mold and Moisture Project, a HUD Healthy Homes Program, organized for a room-by-room inspection. The team recorded information on water damage and evidence of mold for all rooms inspected. Additionally, the team inspected the plumbing, localized ventilation, water entry and other moisture source issues in kitchens, bathrooms, crawl spaces, utility rooms and attics.

The exterior of the homes were inspected for rainwater/snow melt management including site grading, roof condition and gutter system.

Whenever possible, the team interviewed residents to gather history on moisture problems, plumbing leaks, winter condensation, health issues, number of occupants and other useful information.

Digital photographs visually recorded notable conditions at each home.

The results of the mold and moisture assessments were compiled on a spreadsheet, with broad categories of common moisture problems noted. This data is presented in Appendix A in this report. The findings from individual house inspections are presented in Appendix B.

SECTION 2 – ST. PAUL ISLAND, FALSE PASS AND KING COVE HOUSING

At all three villages, the assessment team examined housing units for mold and moisture selected by Housing and Maintenance personnel. The homes were all modular one-story homes with 2x6 walls resting on piers. The crawl spaces beneath the homes had unsealed skirting all around, so the crawl spaces were well ventilated but also allowed water to enter. These units do not represent a typical cross-section of the units under their management since their selection was not based on a random sample.

ST. PAUL ISLAND

Approximately 504 Aleut and 259 Non-native persons lived on the island. Of the total of 177 housing units, 105 were owner occupied, 49 were renter occupied, and 23 were vacant. There was an average of 3.6 persons per home. Ninety-six percent of the homes relied on fuel oil or kerosene for heating and six percent heated with electricity.

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The community of False Pass was primarily Aleut. As of the 2000 census, the population of the village was 64. There were 22 households, and 13 families residing in the city. There were 40 housing units.

KING COVE

As of the 2000 census, the population of the village was 792. There were 207 housing units, 170 of which were occupied. Of the occupied units, 103 were owner-occupied and 67 were renter-occupied.

SECTION 3 – FINDINGS

The assessment team found visible, slight to substantial mold growth all through the inspected homes. Mold contamination is always associated with moisture problems. Nine general findings based on the inspection follow.

3.1 Exterior Site Drainage and Rainwater Management

Good site drainage and rainwater management is essential to maintaining dry foundations and homes. Site drainage was poor at seven homes. Three sites were flat with no slope away from the foundation. Three sites sloped toward the home.

No house had a roof drainage system, a condition that can place a tremendous moisture load on the foundation and the home. However, since the homes were not directly coupled with the ground surface, drainage does not impact these homes as it would with a standard crawl space or basement. Further, the preponderance of wind-driven rain limits the benefits of a gutter system. In this situation, gutter systems are less capable of keeping the foundation dry, though it will direct water that falls on the roof away from the home.

Section 4.1 provides a detailed discussion of site drainage and rainwater management.

3.2 Crawl Spaces

No inspected crawl spaces had effective vapor barriers and the soil was damp in all of them. Most crawl spaces were used for storage of materials on which mold can grow. Any direct pathways between the crawl space and the interior spaces allowed mold spores to travel from one to the other.

Figure 1: Combustion air intake in attic

Section 4.2 provides a discussion of good crawl space design.

3.3 Attics

All five inspected attics had some mold growth. A primary cause of this mold was the combustion air intake. Combustion air was drawn into the home from the attic via a grille in the mechanical room. This grille led to a wall cavity that extended into the attic and was capped with fine metal mesh (Figure 1). In addition to providing the combustion air, this also allowed a pathway for moist indoor air to migrate into the attic. This moist air contacted cold roof sheathing, causing mold. The combustion air intake should be redesigned to take air directly from outdoors.

Figure 2: Mold at wall/ceiling junctures

Attics were poorly ventilated. The primary source of ventilation was through a gable end vent that was protected by an exterior building cavity extending from the roof about two-thirds of the way down the home. However, given the general high humidity levels of outdoor air, the value of venting the attics is questionable. If the combustion air was taken from outdoors and all other penetrations to the attic, such as attic hatches, were well sealed so that moisture did not migrate into the attic. Attic ventilation may not be necessary.

Figure 3: Mold at end of marriage joint

Section 4.3 provides a discussion of attics.

3.4 Interior Surface Mold

Winter moisture condensation caused mold in several homes. Mold growth was visible in bedroom closets, at wall/ceiling junctures (Figure 2), at the ceiling marriage joint between sections of modular units (Figure 3) and at the base of exterior walls (Figure 4).

Figure 4: Mold at base of wall in exterior corner

Condensation occurs when moisture-laden air comes in contact with a building surface that is chilled below the dew point (temperature at which dew begins to form or vapor condenses into a liquid) of the air. This problem indicates a combination of two factors:

- High wintertime moisture load (relative humidity).
- Lower than desired surface temperature.

Lowering the moisture load and/or insulating or heating surfaces to prevent cold surface temperatures can treat the problem.

Section 4.4 discusses condensation issues.

3.5 Bathroom and Kitchen Exhaust Ventilation

Bathrooms experience high moisture loads and show the first signs of mold growth because of the recurring high moisture load. Bathroom exhaust ventilation can substantially reduce interior moisture loads.

Five homes had problematic bathroom fans; of which two were unplugged, one had bad bearings, one had low flow, and one did not operate. There was an additional home without a bathroom fan. Also one home had the utilities turned off thus the operation of the fan could not be evaluated. Maintenance of bathroom fans and replacement of broken fans should be high on the priority list.

At a minimum, bathroom exhaust fans should provide a ventilation rate of 70 CFM. It is desirable to wire these fans to operate when the bathroom light is turned on. Fan delay timers keep fans operating for a selected amount of time after the light is turned off to provide additional ventilation. Because of the reluctance of occupants to use noisy fans, select quiet fans with a sone rating no greater than 1.0. Duct the fans outside rather than terminating in the attic.

Kitchens also often experience high moisture loads during cooking. Remove this moisture via range hoods that exhaust to the outside. All the range hoods in the inspected homes were recirculating which vent moisture back into the home. One home in King Cove did not have any range hood, and one in St. Paul had a broken one. Install range hood fans that exhaust to the outside in each home.

Section 4.5 discusses localized exhaust ventilation.

3.6 Heating Method and Heat Distribution

All but one home had an oil-fired boiler system with hydronic baseboard heating. One home had an oil-fired forced-air central heating system. Heating methods and heat distribution play a vital role in preventing wintertime mold and moisture problems.

Figure 5: Flame roll-out on hot water heater

Distribute heat evenly throughout the home. Remote bedrooms are often colder than the rest of the home, causing water vapor condensation on cold exterior walls, particularly in closets and at the junction between two or more room surfaces due to the presence of thermal bridges at wall intersections.

Some flues were uncapped, allowing rainwater to enter the flues, which could corrode and cause premature failure of the boiler and/or water heater. Cap these well to prevent any rain from entering.

Figure 6: Loose siding

Combustion appliances must have sufficient air for proper combustion. Because the mechanical rooms were often extremely hot, occupants tended to keep those rooms closed. If the combustion air intake was partially blocked, it could be difficult for the boiler or water heater to get enough air to properly function. In one home there was evidence of flame rollout on the water heater (Figure 5). In this home the combustion air was brought up from the crawl space via a floor register, not from the attic. When personal items were left on the register and the door was closed, the appliance did not have enough air. An undercut at the bottom of the mechanical room door, could provide sufficient space to allow home air to enter the room when required.

Heating systems are discussed in Section 4.6.

3.7 Envelope Leakage Issues

Figure 7: Loose siding and flashing allowing water infiltration

Envelope integrity was a problem in some King Cove homes. Loose wood siding allowed air and water to enter at the base of the wall. Wind driven rain, which is common in these areas, made its way into the flooring system and in several instances had rotted the perimeter joist and adjacent subfloor. Note the loose siding in Figure 6 and the gap between the siding and flashing in Figure 7. There were air barriers behind the siding, but these were not sealed to the flashing.

Residents also mentioned that during certain weather conditions, water would leak from the ceiling at the marriage joint. The only source for this water is from water leaking into the roof system at the ridge.

Siding issues are discussed in Section 4.7.

3.8 Plumbing Leakage Issues

At a King Cove tribal meeting, the team was informed that the community had had several instances of pin-hole leaks in copper plumbing supply lines. Naturally, plumbing leaks such as this can cause great damage if they occur inside walls and are not known to exist until they manifest themselves as a major problem. Mold will undoubtedly also result from these types of problems.

Leaky plumbing beneath vanities and kitchen sinks was common. When left unrepaired, mold grows and the cabinets deteriorate. These apparently minor problems can cause a lot of damage. Occupants should immediately contact housing so that the leaks can be repaired. In some cases occupants had attempted plumbing repairs, using inappropriate materials, such as expanding foam, packing tape, electrical tape, and twine.

There were multiple reports of frozen and burst pipes that had caused widespread flooding. Insulate and wrap pipes with heat tape to prevent freezing.

Two homes had leaky plumbing fixtures such as sinks, tubs, and toilets. In addition to being a waste of water, this constant flow of cold water through the pipes can cause condensation on the pipes and toilet tanks. This condensation can drip onto surfaces that can support mold growth or otherwise cause rotting of building materials.

Plumbing problems are discussed in Section 4.8.

SECTION 4 - TECHNICAL DISCUSSIONS AND RECOMMENDATIONS

The following discussions and recommendations are based on the nine general findings identified during the site visit to the St. Paul, False Pass, and King Cove.

4.1 Site Drainage and Rainwater Management

Site Drainage

Figure 8: Wet crawl space in St. Paul

Poor site drainage typically results in wet foundations and the problems associated with them. The housing in St. Paul, False Pass and King Cove are not as susceptible to poor site drainage because the homes are separated from the ground beneath them by being either up on piers (with skirting) or having perimeter stem walls, neither of which are airtight. The floors are insulated and sealed on the bottom of the joists with plywood, keeping moisture beneath the homes less a concern than with conventional construction. However, particularly in St. Paul where the perimeter stem walls were tighter than the pier foundations in False Pass or King Cove, it is still not desirable to expose the bottom side of the belly-board to high humidity. Figure 8 highlights moisture problems beneath one of the homes in St. Paul.

Although not as critical as in standard construction, the following discussion regarding site drainage still applies to housing in St. Paul, False Pass and King Cove.

Design and build the home so rain moves to the edge of the roof, falls on a soil surface, percolates downward through the soil—more in sandy soils and less in clayey soils. The water that does not percolate downward will move along the soil surface following the slope, out to the downhill edge of the site. Homes that allow water to accumulate in the soil in contact with the foundation will develop moisture problems. The best way to prevent mold and moisture problems in homes is to ensure that rainwater moves off the roof, across the site and off the property. In a well-managed property, the soil in contact with the foundation is the driest soil on the site following a rainstorm. Homes with dry foundations (basements, crawl spaces and slabs) are usually dry homes. Two general rules and some specific guidelines to keep the foundation dry by keeping the soil next to the foundation dry follow:

1. The first general rule concerns concentration – the greatest concentration of water causes the worst damage. A valley on a roof acts like a funnel, with the greatest concentration of water at the base of the valley. Gutters also act like funnels that collect water from the edge of the roof and direct it to the downspouts. On the land, valleys and swales act like collectors or funnels that concentrate the water on the site. Water management design that makes use of funnels (such as valleys, gutters or swales) requires maintenance to ensure the funnels work as intended. Frequently water damage occurs where a valley, gutter or swale is blocked.

2. The second general rule concerns the ground roof rule - treat the soil surface as if it were a low-slope roof surface. Pitch the ground surface away from the home - the steeper the pitch, the better the drainage. All the water should move to the low edge of the site, and how best should it get there. Do not allow areas to remain near the home that can act as water collectors.

Specific site drainage guidelines include:

- Build the home on a crown, not in a hole. With sufficient exposed foundation, site grading at the home can be improved. If the home hugs the ground, improvements at the foundation are more difficult. A minimum of 8 inches of exposed foundation should be between the ground and the beginning of the siding.

- Identify localized dips and holes immediately adjacent to the foundation, fill them with dirt, and tamp the fill material to prevent future settling. Use enough fill material so drainage occurs away from the foundation.

- If the home has no gutters, then the base of the soil around the home has to act as a gutter. The ground surface should prevent splash back onto the siding of the house and should have enough pitch to effectively move water away from the house.

- Good tamping or compaction of the backfill is very helpful in keeping water on the surface where it can be managed by slope. Soil at the outside corners of the foundation, where the downspouts are usually found, should always be tamped so the corners will not collapse inward.

- Bushes and other plantings can help with drainage if their root balls soak up a lot of water. They can be planted strategically near downspouts so that downspout extenders are less likely to be kicked off or removed during lawn mowing.

Rainwater Management

In most locations rainwater management is critical to maintaining a dry environment surrounding a home's foundation. Weather characteristics in the Aleutian Island Communities pose specific problems: extremely high winds and ice buildup on gutters make them very susceptible to damage. No inspected homes in these Communities had gutters. Generous overhangs that shed water away from the homes serves these homes better. Site drainage becomes very important if water is not managed as it drains off roofs.

4.2 Crawl Space Design

Moisture entry and evaporation from foundation sources are major contributors to the moisture load in a home. Because they are rarely visited or inspected and problems go unaddressed, crawl spaces are particularly notorious for leading to foundation moisture problems. When moisture entry is acute, framing and subflooring can deteriorate and support mold. The following points relate to crawl spaces in general, regardless of the location of the thermal boundary:

- Crawl spaces should have easy access and good lighting to enable regular inspections. There should be sufficient headroom to allow for reasonable ease of movement and ability to perform repairs and improvements.

- Water in crawl spaces typically comes from poor rainwater management outdoors, plumbing leaks, air conditioner condensate or water softener discharge. Poor rainwater management is by far the leading source of water in crawl spaces.

- Crawl spaces should be covered with a ground material to prevent the migration of moisture in the soil up into the home: a slab of concrete, a polyethylene sheet or other vapor-proof material. Seal the ground cover to the foundation walls and seal all joints and seams. Seal the ground cover and foundation piers interior to the crawl space.

- Insulate crawl spaces. Two ways to insulate a crawl space depend on where the thermal boundary is established. The thermal boundary is the building section that separates conditioned space from outside conditions. Insulation can either be placed on the crawl space walls (placing the crawl space inside the thermal boundary) or in the floor of the home (placing the crawl space outside the thermal boundary). If the crawl space contains mechanical systems (plumbing, ductwork), the space should be inside the thermal boundary.

The building styles in St. Paul, False Pass, and King Cove (piers or stem walls, with skirting) makes it much more practical to insulate at the floor so hat the crawl space is outside the thermal boundary. It is also recommended that any intentional vents in the skirting be sealed. The skirting already allows a substantial quantity of air through, and large openings in the skirting can allow driving rain to enter.

4.3 Attics

A non-air sealed attic hatch is a type of bypass or alternate space through which air can pass (Figure 9). Mold can condense on access hatch blocking if not air sealed. Seal the hatches with weatherstripping or gasket (Figure 9). Install latches to lock the hatches in place and provide positive closure.

Insulate attic hatches to R38 but no less than R19. A lightweight attic hatch may be cut from damaged insulated foam core doors. The door has an R-value around 7. Attach batt insulation to the back of the door panel to achieve the desired R-value. The pre-finished door panel is lightweight and requires no additional painting.

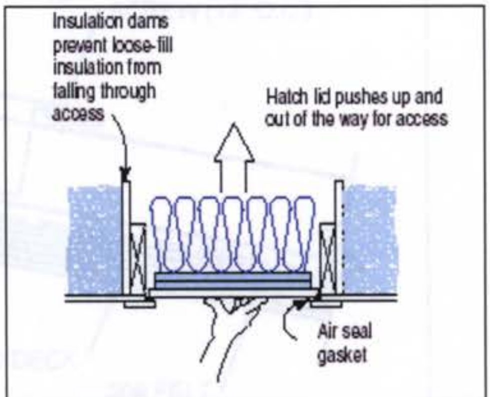

Figure 9 – Air sealed and insulated attic access hatch

Many individuals, organizations, and model codes stress the importance of attic ventilation. While it has some benefits, it also has some drawbacks. Wind washing of insulation at the edge is one major drawback. Designs without attic ventilation may improve the performance of the eave area. Most designs without ventilation rely upon the verified airtight ceiling plane for good moisture performance. Attic venting in moist areas such as the Aleutians should be considered optional. For more information about the benefits and drawbacks of attic ventilation see "Issues Related to the Venting of Attics and Cathedral Ceilings" at http://www.fpl.fs.fed.us/documnts/pdf1999/tenwo99a.pdf.

Do not place terminations of exhaust fans or combustion air vents in the attic. Both exhaust fans and combustion air vents are pathways through which warm, moist air can travel. As this air enters the attic, it can condense on cold sheathing and lead to a mold problem.

Insulate the attics well, all the way to the eaves. This may require additional attention to force insulation into the narrow perimeter of the attic.

Water through the ridge of the roofs was likely the source of leakage through the marriage joint in the St. Paul homes.

Address this by the following method:

1. Remove the ridge cap.

2. If there is a gasket in place beneath the ridge cap, remove it.

3. Install a new gasket at the top of each side of the roof (an example is shown in Figure 10, where the gasket is the EPDM closure). There are pre-formed gaskets designed to fit over various different types of metal roofs.

4. Use a butylene caulk, at least on the bottom of the upslope side of the gasket, though caulk at both the top and the bottom is preferable (Figure 10).

5) Reinstall ridge cap.

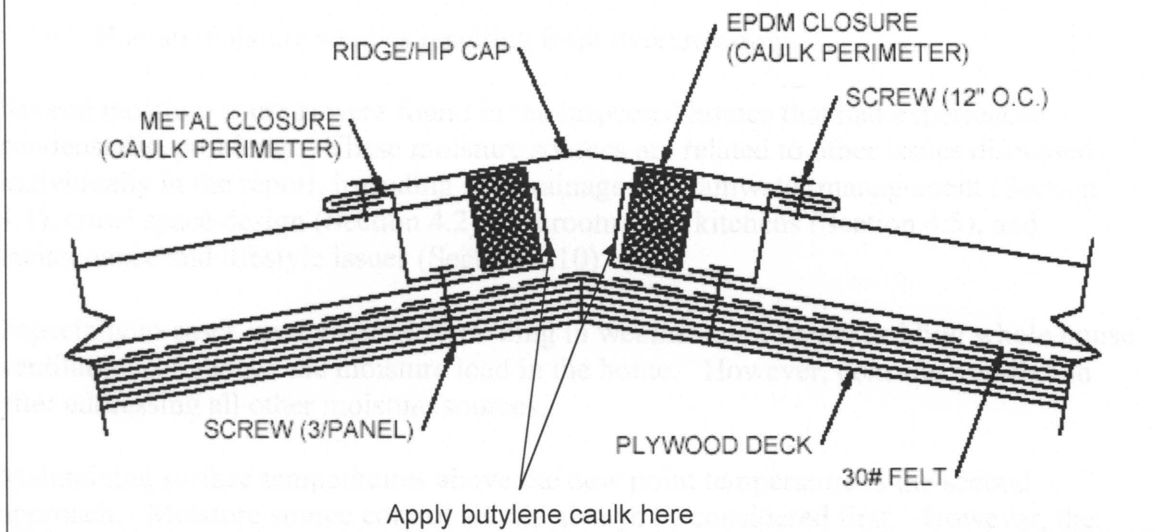

Figure 10. Example of detailing for sealing the ridge cap.

4.4 Winter Condensation Problems

Condensation occurs when moisture-laden air comes in contact with a building surface that is chilled below the dew point of the air. When this happens, the moisture content of the materials at the location increases, often up to saturation, and mold grows on the surfaces. This problem indicates a combination of two factors:

1. A home with a high wintertime moisture load (relative humidity), and

2. Areas of the building that are below the desired interior temperature.

Two approaches could address these problems:

1. Identify the moisture sources that contribute to the elevated humidity in the home and reduce or eliminate these moisture sources.

2. Identify the cause of the chilled surface and add insulation or airflow improvements to reduce or eliminate the chilling of the surface.

Identifying and reducing moisture sources to lower relative humidity in the winter should be the first step. Moisture sources can include:

- Foundation moisture sources i.e. wet basements and crawl spaces.
- Bathroom moisture sources due to lack of effective localized ventilation.
- Human moisture sources resulting from overcrowding.

Several moisture sources were found in the inspected homes that had experienced condensation problems. These moisture sources are related to other issues discussed individually in the report, including site drainage and rainwater management (Section 4.1), crawl space design (Section 4.2), bathrooms and kitchens (Section 4.5), and maintenance and lifestyle issues (Section 4.10).

Especially in cases involving overcrowding in weather-tight homes, adding whole house ventilation can reduce the moisture load in the home. However, consider ventilation after addressing all other moisture sources.

Maintaining surface temperatures above the dew point temperature is the second approach. Moisture source control should always be considered first. However, the problem can occur at a reasonable interior humidity if there is a specific construction flaw that allows a surface to get chilled in the winter.

A common condition contributing to winter condensation and mold problems occurs in closets on an exterior wall. The design and use of closets create this common condition, specifically:

- Lack of heat supplied to closets combined with closed closet doors.
- Lack of airflow in closets, which could distribute heat to the closet exterior surface.
- Closet clutter that prevents airflow and heat reaching the closet's exterior walls.
- Clothes hanging next to walls act as insulation lowering the temperatures of the walls.

Since a relatively cold room contributes to mold growth, ensuring that the exterior wall of the closet does not get chilled will help prevent this mold growth. Keep closets uncluttered and maintain some distance between the clothes and the exterior walls. Louver closet doors and keep the room at a comfortable temperature. Insulate the exterior walls. Again, keep the moisture load in the home at a minimum.

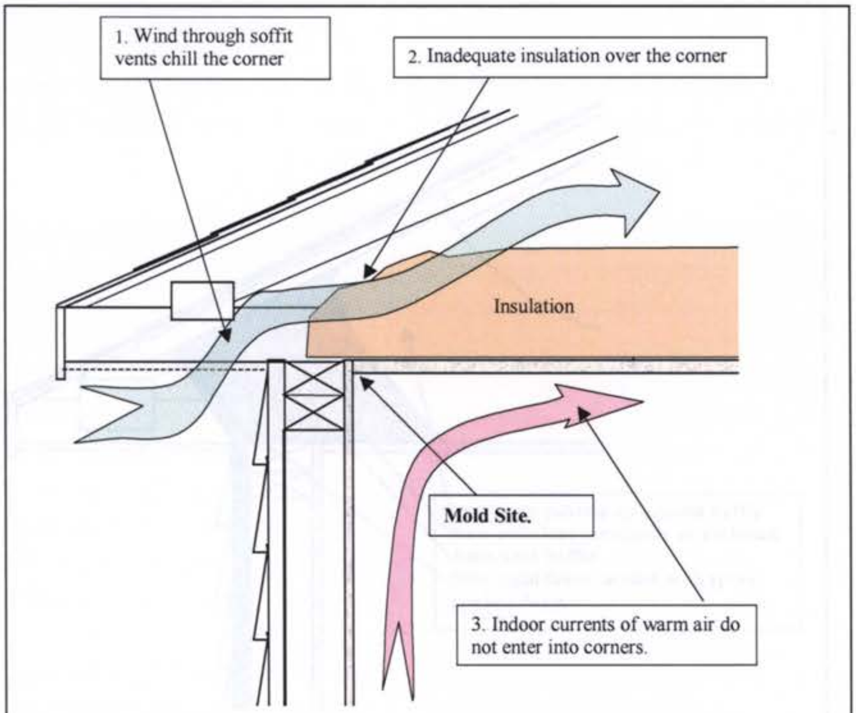

Figure 11: Wall-ceiling corners are cold because of: 1. Wind movement through soffit vents. 2. Smaller amounts of insulation at the corner. 3. Corner is outside the movement of warm air currents indoors.

The exterior wall/ceiling junctures often experience chilling and subsequent condensation and mold contamination, especially in northern climates in older ranch-style homes with low-pitched roofs.

Three reasons why the exterior wall/ceiling juncture becomes cold follow (Figure 11):

1. Cold wind entering through soffit vents and passing through the porous insulation material, degrading its thermal performance.

2. Poorly installed insulation resulting in reduced amounts of insulation in the corners.

3. The geometry of the corner may prevent slow-moving currents of warm air from reaching into the corners.

Dark spots occur on interior surfaces that are chilled due to poor insulation. In new construction, use a raised-heel truss and carefully insulate at the wall-roof joints. It is difficult to adequately insulate the exterior edge of the attic, especially in homes with low-pitch roofs. With batt insulation, use special pusher sticks to push the insulation out to the edge. With loose fill insulation, prepare the outside edge correctly so that it is packed with insulation.

In existing homes, consider retrofitting the wall-roof joint (Figure 12). The work is done from the outside. Remove the soffit material. Install a fiberglass baffle in each cavity space. Push the existing insulation back up against the sheathing or the baffle. Blow in new cellulose insulation or pack in fiberglass insulation into the cavity. Then install pre-cut rectangles of rigid foam insulation to block air flow. If blowing in loose-fill insulation, the rigid foam insulation should be installed first, followed by blown insulation. Use spray-applied foam insulation to keep the rigid rectangle in place. Replace the soffit. If the attic is ventilated, make sure that nothing blocks the baffles.

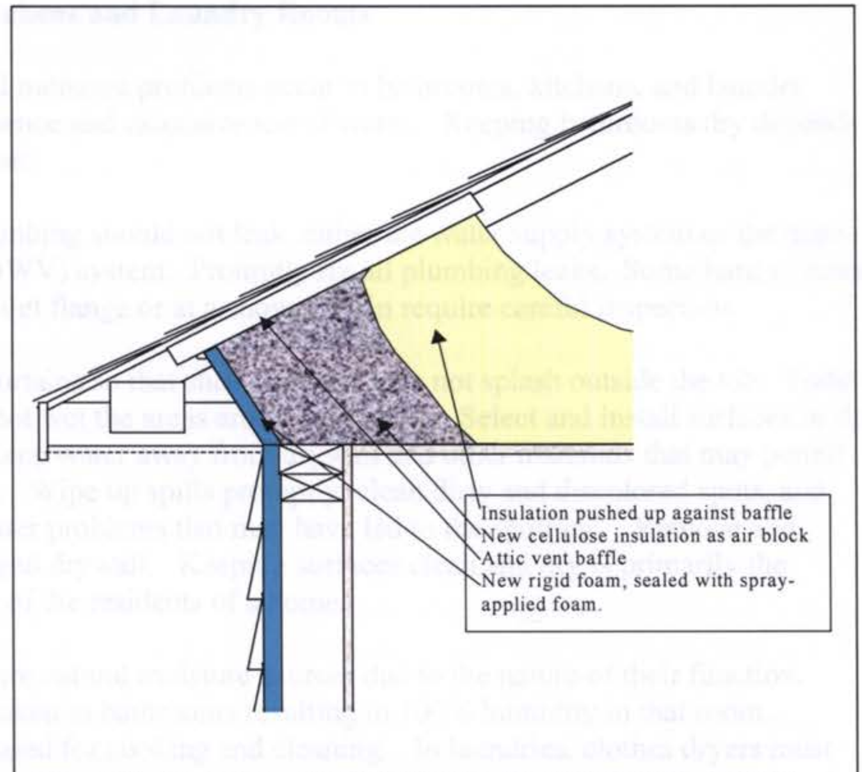

Figure 12: Insulation retrofit for the juncture between the exterior wall and the roof-ceiling assembly. Note that this retrofit is done from the outside.

The retrofit described above is designed to keep the wall/ceiling juncture warm and eliminate the condensation site. These efforts to lower the moisture load in the house and reduce the relative humidity also help prevent wintertime mold and moisture problems.

Most homes in the Aleutians consist of two modular units fastened together at the centerline of the home. The longitudinal marriage joint between the two modular units was a common location for mold at the ceiling. This is a location where structural members are fastened together. Figure 13 illustrates the marriage joint from in the attic and although everything around the marriage joint appears well insulated, it reveals that the structural members are not insulated causing a thermal bridge along this particular junction. To resolve the mold problem on the interior, insulate this junction in the attic with fiberglass insulation. Lay the insulation over the top of the lumber and ensure it is also between the vertical truss members on each side of the horizontal members.

Figure 13: Uninsulated marriage joint

4.5 Bathrooms, Kitchens and Laundry Rooms

Many home mold and moisture problems occur in bathrooms, kitchens, and laundry rooms due to the presence and extensive use of water. Keeping bathrooms dry depends on care in several areas:

1. Bathroom plumbing should not leak, either the water supply system or the drain-waste-vent (DWV) system. Promptly fix all plumbing leaks. Some hard to detect leaks at the toilet flange or at a shower drain require careful inspection.

2. Use shower curtains so that shower water does not splash outside the tub. Toilet users should not wet the areas around the toilet. Select and install surfaces in the bathroom to keep water away from drywall and other materials that may permit mold to grow. Wipe up spills promptly, clean dirty and discolored spots, and correct the water problems that may have led to the spotting. Remove and replace damaged drywall. Keeping surfaces clean and dry is primarily the responsibility of the residents of a home.

3. Some rooms are natural moisture sources due to the nature of their function. Showers are taken in bathrooms resulting in 100% humidity in that room. Kitchens are used for cooking and cleaning. In laundries, clothes dryers must remove large quantities of water from wet clothes. By removing moisture at the source in these areas, exhaust ventilation serves as a source control strategy for reducing the moisture load in a home. Exhaust ventilation dilutes the moisture and places the room in a negative pressure, thus limiting the spread of moisture to the rest of the home until most of the moisture has been removed to the outside.

4. Not only bathroom and kitchen exhaust fans, but also clothes dryers should vent to the outside rather than into the living space. Venting to the basement, crawl space and attic can lead to moisture problems occurring in these areas. For this reason, localized exhaust ventilation requires ductwork. If the vent discharges through the roof, make sure the vent has an effective check valve to prevent wind blowing back through the vent.

5. Bathroom exhaust fans should exhaust no less than 50 to 70 cubic feet per minute (CFM). The effectiveness of exhaust fans depends on the power of the exhaust fan, length and type of exhaust duct and cleanliness of the fan grille. When there is excessive resistance in the ductwork, the exhaust fan motor may not be powerful enough to vent sufficient airflow through the duct. The longer the duct length, the greater the static pressure in the duct and the less air flow through the duct. Turns and bends in the ductwork also increase the static pressure and reduce flow. Similarly, a smooth duct provides less resistance and improved flow than ribbed ductwork. Round, smooth sheet metal ductwork is recommended for all types of exhaust ventilation. Generally, a larger duct of shorter length, with few bends or elbows, is preferred. A dirty intake grille will also greatly increase resistance and reduce airflow.

6. Noisy exhaust fans are not likely to be used, so exhaust fans with a low sone rating should be selected. To ensure they are used, consider:

   - Exhaust fan hard-wired to the bathroom light.
   - Exhaust fan on a timer, to extend moisture dilution time after showering.

   A good system features both of these features. The fan is hard-wired to the light, but also runs for a programmed period following bathroom use. (Available from Energy Federation Incorporated, www.efi.org, Fan/Light Time Delay Switch). Residents should be encouraged to always use the bathroom exhaust vent.

4.6 Heating Systems and Moisture Control

In winter, heating systems provide occupant comfort. Heating systems also impact winter moisture problems in several ways. Two critical ways follow:

1. The heating system is a major determinant of the temperature of interior surfaces. If heat is inadequate or poorly distributed, some wall and ceiling surfaces may be chilled near or below the dew point temperature leading to condensation problems. Occupants play a role in this if they close off rooms, cover supply ducts, block airflow to exterior walls, or adjust the thermostat too low.

2. With the exception of electric heat, most heating systems depend on the combustion of fuels. A major byproduct of combustion is water vapor. If a combustion appliance is improperly vented, or not vented at all, then the heating system can contribute significant amounts of moisture into the interior air.

With regard to the first issue, central heating systems are preferred over stationary, single source heating systems, such as propane space heaters and wood stoves. Central heating systems feature ductwork that supply heated air (or heated water to radiators in hydronic systems) to all the major living spaces of the home. A properly designed and functioning heating plant and distribution system keeps all the rooms warm. This minimizes the potential for chilled surfaces, which are potential condensation and mold contamination sites.

Economic reasons sometimes cause residents to limit the heating of spaces such as bedrooms. Although this is understandable, it can also contribute to chilled exterior surfaces and result in condensation and mold growth.

With regard to the second issue, any appliance that burns a fuel, such as gas, fuel oil, or wood, produces moisture. Generally, for every molecule of fuel consumed, two molecules of water vapor are produced. If the combustion gases are not well ventilated to the outside of a home, the appliance can contribute large quantities of moisture into the indoor air. The excessive moisture load in the air can be a major contributor to winter moisture problems in the home.

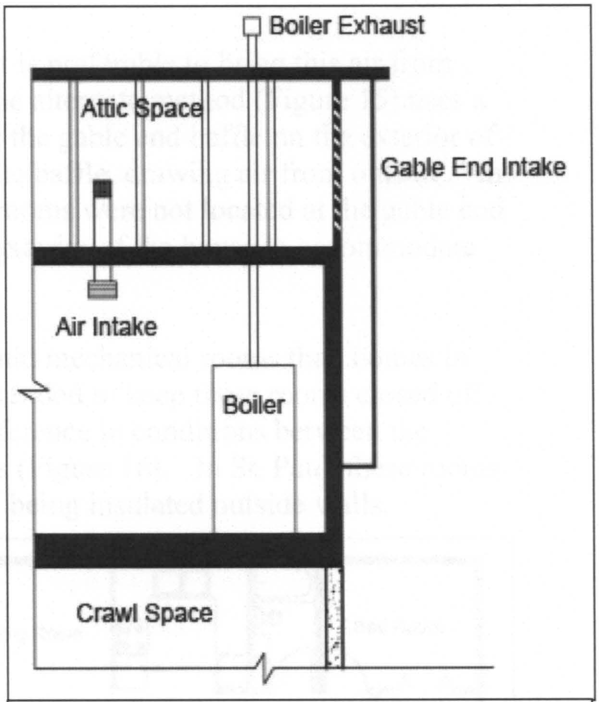

Figure 14: Existing - Combustion air intake from attic

Combustion air for the boiler and water heater was provided through an 8"x8" grille located near the ceiling in the mechanical room. The grille tapped into a wall cavity between the studs that was then ducted into the attic. Combustion air was being drawn from the attic. There are problems with this approach to providing combustion air, which is evidenced by mold on roof sheathing proximate to the combustion air intake.

1. The washer and dryer are in the same room as the boiler and water heater. Even when properly hooked-up and vented, both units will contribute some moisture to the mechanical room, and much moisture if the dryer is not properly vented.

2. The room is usually warmer than the rest of the house because of the constant heat loss from the water heater and boiler.

3. When the mechanical unit and water heater are idle, warm moist air will tend to migrate through the combustion air duct into the attic.

4. In the attic, the warm moist air will condense on cooler surfaces such as the bottom side of the roof sheathing.

5. The wet sheathing will begin to mold and delaminate. This is not necessarily a rapid process, but over time compromises the roof structure. Mold was found above the combustion air intake in several homes.

6. When the mechanical units call for combustion air, air from the attic, now possibly contaminated with mold, is drawn into the mechanical room.

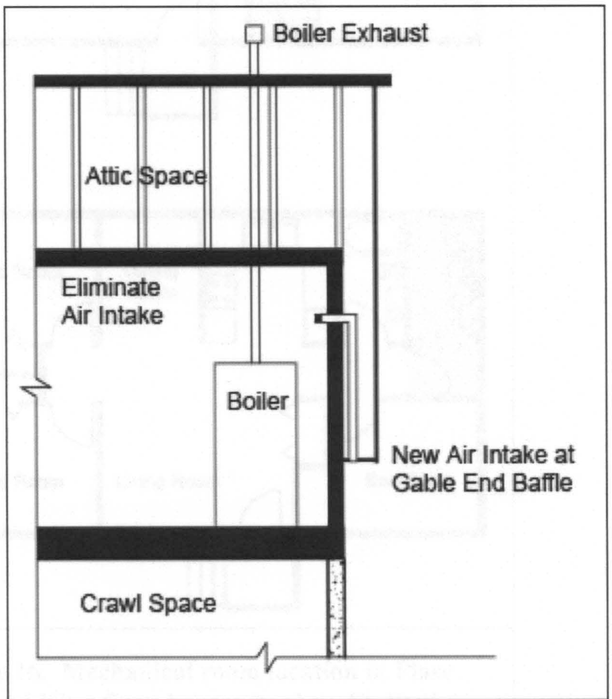

Figure 15: Proposed - Combustion air from outside instead of from the attic

Instead of drawing combustion air from the attic, it is preferable to bring this air from outside. Figure 14 shows the current method. The alternate method (Figure 15) uses a duct that penetrates the mechanical room wall into the gable end baffle on the exterior of the house. The duct then goes to the opening of the baffle, drawing air from outside. In False Pass and King Cove, where the mechanical rooms were not located at the gable end of the house, a separate baffle can be built on the exterior of the house to accommodate these intakes.

Homes in St. Paul tended to have hotter, more humid mechanical rooms than homes in False Pass or King Cove. In all cases, occupants tended to keep these rooms closed off, in large part because of these conditions. The difference in conditions between the villages is likely due to the location of these rooms (Figure 16). In St. Paul, these rooms were at the end of the home, with half of the walls being insulated outside walls. Conversely, in False Pass and King Cove, these rooms were more centrally located, such that most of the walls were uninsulated, interior walls. With less insulation in the surrounding walls, the heat from the boiler and water heater can more easily conduct through to the living space, which can help meet the thermostat set point and keep a more uniform temperature. In St. Paul, the heat is more readily retained in the mechanical room.

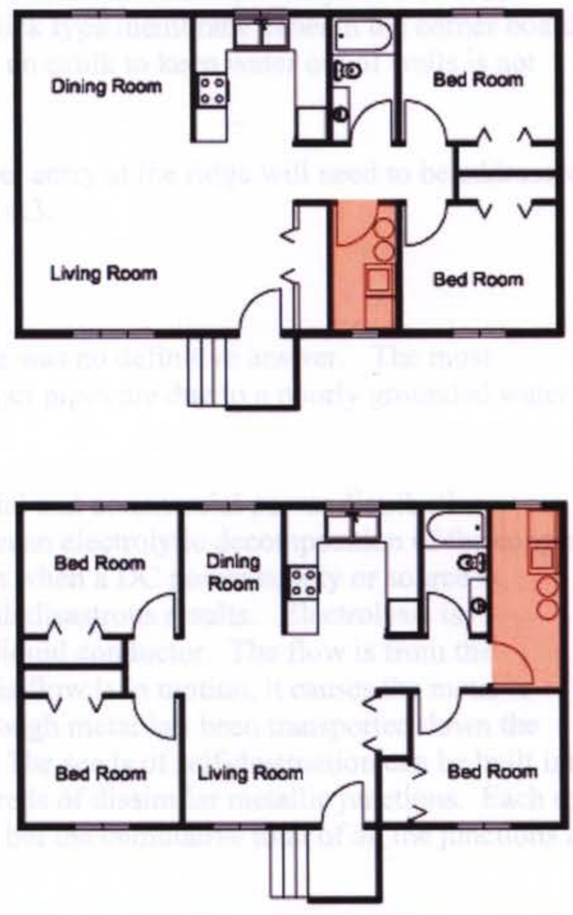

Figure 16. Mechanical room location in Flase Pass and King Cove houses (top) vs. St. Paul

4.7 Envelope Issues

Due to the severe weather conditions, particularly the high winds and wind driven rain, encountered in the Aleutian Island Communities, detailing and execution of siding and roofing deserves particular attention. At King Cove the repeated wetting of wood siding had caused the nails to work their way out of the walls and left the siding loose. Large gaps between clapboards allowed wind driven water to enter the walls and penetrate the walls and flooring system causing rot in structural members. It appeared that the nails used to secure the siding were not ring-shank nails.

Figure 17: Dried out caulk

Prior to renailing the siding, remove the lower portions of the siding to below the windows. Cover this area with a peel-and-stick type membrane that laps over the metal flashing at the base of the wall. Replace and fasten the siding with ring-shank nails to mitigate the problem of the siding working itself loose. Resecure all the loose siding with ring-shank nails.

Reseal between clapboards with caulk, vertical corner boards and other trim. In most cases the caulk had separated from one or both of the applied surfaces rendering it useless (Figure 17). Rather than using caulk to seal the joint between various siding components, it is better to detail the joint to make it more difficult for water to find its way into the wall. For example, overlapping the corner boards with a larger board that covers the seam between the siding and corner board shields the joint from direct infiltration. In addition, using a peel-and-stick type membrane beneath the corner boards provides a second line of defense. Relying on caulk to keep water out of walls is not recommended and temporary at best.

The leaking at the marriage joint due to water entry at the ridge will need to be addressed at the ridge. This was discussed in Section 4.3.

4.8 Plumbing Problems

The pinhole leaks were researched and there was no definitive answer. The most common opinion is that the pinholes in copper pipes are due to a poorly grounded water system or acidic water.

Alternating current such as used in residential and commercial power distribution systems lacks the ability to initiate or sustain an electrolytic decomposition of the copper piping. However, there are some occasions when a DC power supply or source is improperly grounded to a piping system with disastrous results. Electrolysis is accomplished by the flow of electrons in a liquid conductor. The flow is from the positive areas to the less positive. While this flow is in motion, it causes the metal to dissolve into the liquid (or leach). After enough metal has been transported down the drain, an undesirable pin-hole may appear. The seeds of self-destruction can be built into a water distribution system by having hundreds of dissimilar metallic junctions. Each of these junctions produces a millivolt or two, but the cumulative total of all the junctions is sufficient to power the destruction process.

This is not an uncommon problem and research is being conducted to determine the cause of these pinholes.

4.9 Maintenance and Lifestyle Issues

St. Paul, False Pass and King Cove had some maintenance and lifestyle issues that contribute to mold and moisture conditions:

1. Occupant attention to cleanliness can reduce mold problems. In bathrooms and other wet areas, regular cleaning can help keep mold conditions under control. Maintenance issues are discussed in Section 5.

2. Certain housekeeping habits contributed to mold growth on the interior of the structures: overstuffed closets, covering windows with heavy drapery and inadequate cleaning regimens can all contribute to mold growth. Modifying occupant lifestyles is as important as solving technical problems. In general, most mold problems can be resolved; however, without addressing occupant lifestyle many mold problems will rapidly resurface.

3. When the number of residents living in a home exceeds the expected capacity of the house, the moisture burden increases. Each person participates in moisture-producing activities (breathing, cooking, washing, etc.) increasing the moisture load. If the number of people living in the home doubles the set capacity of a house, the moisture load from human sources also doubles.

4. In the absence of a mechanical ventilation system, natural infiltration (air leakage) provides fresh air in homes during the winter. This fresh, dry, winter air dilutes the moisture in the interior air and helps keep relative humidity under control. The amount of infiltration (the air change rate) that occurs in a home varies with the home. Some homes are naturally leaky, while others are more airtight. A particularly tight house may exhibit high relative humidity in the winter, which could lead to moisture and mold problems.

When a home is both overcrowded and has a low air change rate, an excessive moisture load can occur maximizing the potential for localized condensation and mold growth.

If winter condensation problems occur in a crowded home, identify and minimize all other sources of moisture. If the problems persist, then test the home for its relative tightness or leakiness using a blower door test. Agencies responsible for performing low-income weatherization usually have the equipment and expertise to perform this test and can confirm whether the air change is too low for the size of a home and its number of residents. If this proves to be the case, then providing additional ventilation for the home should be considered. This can be accomplished several ways:

1. Installing a good bathroom exhaust fan on a humidistat control.

2. If the house has a central forced-air heating system, the existing fan and ductwork can be augmented with a connecting duct to the exterior and controls to provide fresh air circulation.

The services of a mechanical engineer with experience in residential ventilation systems would be valuable when addressing a problem of this kind.

Human occupation also produces moisture in buildings. Humans are similar to internal combustion engines, and respiration, the act of breathing, produces considerable moisture. Other human activities and preferences also produce moisture:

- Showering
- Cooking
- Cleaning
- Drying laundry indoors
- Accidental spills
- House plants
- Firewood storage
- The use of humidifiers and vaporizers

SECTION 5 - HOUSING STAFF ISSUES

5.1 General

Many moisture problems and consequent mold contamination result from deferred maintenance. If water infiltration problems from plumbing, roofing, or foundation sources linger, a small problem can turn into a large problem. A minor water infiltration problem with a small potential for mold can turn into a major contamination site, if not repaired quickly. Unfortunately water leaks often go unreported and unattended. Attend to roof and plumbing leaks promptly.

A housing authority's best defense against mold and moisture complaints is its maintenance department. A good proactive maintenance program guards against mold and moisture problems by including the following procedures:

- Perform regular inspections of properties to identify problematic moisture conditions.

- Encourage residents to report moisture problems.

- Respond promptly to identified and reported moisture problems to prevent excessive mold contamination.

Clearly, a prompt response implies a partnership between tenants and the housing authority. Residents must promptly report mold and moisture problems, and maintenance staff must promptly respond to those reports. If either party defers in their responsibility, the list of deferred maintenance items will grow, and small moisture and mold problems will turn into major problems with possibly severe mold contamination. Train maintenance staff in the following items to assist in solving and eliminating moisture and mold problems:

General

- What is mold
- What causes mold
- Other Indoor Air Quality (IAQ) problems
- Sources of moisture
- Moisture assessment procedures

Exterior

- Site drainage
- Maintenance of roof drainage systems (gutters, downspouts, etc.)
- Paving adjacent to homes
- Repair of roofs and roof flashings

Foundations

- Crawl space design issues
- Sump pump system preferred, installation, and disposal of water

Attics

- Attic bypasses
- Attic hatches
- Attic ventilation
- Insulation
- Wall/ceiling junctures

Mechanical

- Bathroom and kitchen exhaust fans
- Venting exhaust fans to the exterior
- Plumbing leaks
- Humidifiers
- Unvented appliances

Mold Remediation

- Clean-up
- When to call for outside help

At the same time, occupants should be aware of their crucial role in preventing mold and moisture problems. A number of occupant issues bear directly on the causes and severity of moisture and mold problems. Occupants should receive training on the following topics to assist in solving and eliminating moisture and mold problems in their homes:

- What is mold and what causes it
- Use of exhaust fans
- Regular bathroom cleaning
- Avoidance of clutter in critical locations (exterior walls of closets, etc.)
- General housekeeping
- Use of crawl spaces
- Gutter and downspout maintenance
- Difference between plumbing leaks and water condensation on pipes
- Use of sump pumps
- Humidifiers and dehumidifiers

5.2 Remodel & New Construction Recommendations

The following are some recommendations for rehabilitation and new construction projects for the Aleutian Island Communities.

On the Exterior of the Home

- Siting & elevation of the home:

  See Section 4.1 - Site Drainage and Rainwater Management

- Gutter and drainage systems:

  See Section 4.1 - Site Drainage and Rainwater Management

- Foundation waterproofing and drainage for new construction:

  Keeping soil dry next to a foundation is the preferable approach for maintaining a dry basement or crawl spaces. However, there are occasions where this may not be possible and a good second line of defense is to use a high quality waterproofing membrane on the exterior face of the foundation wall. There are many trowel or spray applied products on the market. Once applied, these products create a monolithic and highly flexible membrane with crack-bridging properties (e.g. www.appliedtechnologies.com or www.carlisle-ccw.com). These membranes should be protected with either a geotextile covering (e.g. http://www.deltams.com/deltadrain/) or rigid insulation (e.g. DOW Styrofoam Perimate) before backfilling.

  In addition to carefully waterproofing foundation walls, installing drain tile at the base of the foundation wall is necessary to dispose of water that has drained down the face of the wall. Usually this tile is connected to the sump pit, or if possible, run to daylight.

Properly sealing and draining crawl spaces or basement foundation walls is as important as properly installing shingles on a roof. Unfortunately, foundation walls are frequently not provided the same attention as roofs. Roofs are visible and everyone understands that a leaky roof will result in a host of problems. On the other hand, foundations are below grade and not visible, and thus do not appear to be as important as roofs. However, this belief is incorrect. It does not matter whether moisture comes from above or below. All unwanted moisture should be kept outside the building structure. Although foundation leakage may not result in obvious water spots on the ceiling such as from a roof leak, water from a foundation leak can cause structural damage, contribute to mold growth, and compromise habitable spaces. The importance of properly sealing and draining foundations cannot be overemphasized.

- Siding options for new construction and remodel projects:

  There are several criteria that should be considered when selecting the siding for a structure. Performance (maintainability, durability, repairability, permeability, etc.), aesthetics, first-cost, and life-cycle-cost should all be considered. Frequently the selection of siding is based on lowest first-cost. This is unfortunate because basing decisions solely on first-cost precludes all the other criteria that should also be considered in the selection process. The housing authority should carefully scrutinize siding options and not base selection solely on first-cost. Durability of siding should be an important factor in the selection process. Investing a little more initially can result in significant savings later. A life-cycle-cost analysis should be conducted to justify the selection process.

On the Interior of the Home:

- Toilet tank condensation problems:

  One common problem the assessment team has identified in a lot of Indian housing is mold and the deterioration of drywall behind toilet tanks. Due to condensation on the outer surface of the toilet tank, the adjacent wall area is often wet. Since the wet wall behind the toilet tank is difficult to clean, due to limited access, mold grows and the wall deteriorates.

  There are two ways to mitigate this problem:

  1. Install a toilet with an insulated tank. The insulation results in higher toilet tank surface temperatures and thus less surface condensation.

  2. Supply both hot and cold water to the toilet through a mixing valve. The increased water temperature inside the tank will result in less surface

condensation. The supply of hot and cold water through a mixing valve has been implemented at several Indian housing communities with positive results.

- Insulate all plumbing supply lines:

  The temperature of water supplied to Indian housing in the northern United States is very cold. Many of the examined homes had water supply pipes in the basement or crawl spaces that were dripping liquid water due to condensation on their surface. This condensation can contribute a significant amount of water to the interior moisture load. All hot and cold supply piping should be insulated; the hot water lines for energy conservation, the cold water lines to eliminate condensation.

- Ceiling finishes:

  Cleanup of mold growing at the wall to ceiling junction is very difficult, if not impossible, if the ceiling has a rough textured finish. It is highly recommended that ceilings be finished with a smooth or a skip-trowel finish in lieu of a rough popcorn finish.

- Drainage of Condensate:

  One of the by-products from high-efficiency furnaces is water. During winter months, when the furnace is running frequently, these units produce a significant amount of water. Drain water directly to the exterior, into a condensate pump which then pumps the water to a drain or exterior, or into the sump pit from where it can then be pumped to the exterior.

1	2	4	5	6	7	8	10	11	12	13	14	15	16	17	18	19	20	21
Inspection Number	Address	Building Age	Occupancy	Foundation Type	Model and Framing Type	Heat Type	Site Drainage Problems	Gutter System Problems	Leaks from Exterior	Wet Basement or Crawl Space	Kitch. Plumbing Problems	Bath Plumbing Problems	Bathroom Problems	BR Exhaust Ventilation Problems	Kitch. Exhaust Ventilation Problems	Exterior wall/ceiling problems	Attic Problems	Visible Mold (Column #)
1-1SP	St. Paul	17 years	2A: 3C	Perimeter stem walls w/central piers	Ranch: 2X6 Modular	Oil fired boiler w/hydronic heat	Yes	System Absent	No	Yes	Yes	No	No	No	Yes	Yes	Yes	14, 19, 20
1-2SP	St. Paul	17 years	2A: 1C	Perimeter stem walls w/central piers	Ranch: 2X6 Modular	Oil fired boiler w/hydronic heat	Yes	System Absent	No	Yes	No	No	No	Yes	Yes	No	Yes	20
1-3SP	St. Paul	17 years	3A	Perimeter stem walls w/central piers	Ranch: 2X6 Modular	Oil fired boiler w/hydronic heat	Yes	System Absent	No	Yes	Yes	No	Yes	No	Yes	No	Yes	13, 14, 16, 20
1-4SP	St. Paul	17 years	2A: 3C	Perimeter stem walls w/central piers	Ranch: 2X6 Modular	Oil fired boiler w/hydronic heat	Yes	System Absent	No	DNV	Yes	Yes	Yes	Yes	Yes	No	DNV	14, 16
1-1FP	False Pass	18 years	2A: 1C	Piers w/skirting	Ranch: 2X6 Modular	Oil fired boiler w/hydronic heat	Yes	System Absent	No	Yes	Yes	Yes	Yes	No	Yes	No	Yes	20
1-2FP	False Pass	18 years	Vacant	Piers w/skirting	Ranch: 2X6 Modular	Oil fired boiler w/hydronic heat	Yes	System Absent	No	Yes	Yes	No	No	No	Yes	No	DNV	13, 14
1-1KC	King Cove	18 years	Vacant	Piers w/skirting	Ranch: 2X6 Modular	Oil fired boiler w/hydronic heat	No	System Absent	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	DNV	13, 14, 16, 19
1-2KC	King Cove	25 years	2A: 4C	Piers w/skirting	Ranch: 2X6 Modular	Forced-air heat	No	System Absent	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes	12, 19, 20
1-3KC	King Cove	25 years	2A: 2C	Piers w/skirting	Ranch: 2X6 Modular	Oil fired boiler w/hydronic heat	No	System Absent	No	Yes	Yes	Yes	Yes	Yes	Yes	No	DNV	14, 16
1-4KC	King Cove	25 years	1A	Piers w/skirting	Ranch: 2X6 Modular	Oil fired forced-air heat	No	System Absent	Yes	DNV	Yes	Yes	Yes	No Fan	No range hood	Yes	DNV	12, 14, 15, 16, 19
10 Homes							6	10	3	8	8	4	6	6	10	4	5	10

MH = Mutual Help TK = Turnkey/Rent to Own LR = Low Rent

N/A* No electricity to unit during visit
N/A** Owner Not Present
DNV= did not view

Inspection Number: 1-1 FP
Address: False Pass
Model Type: Ranch
Foundation: Piers
Construction: 2 x 6 Wood Frame
Heat Type: Oil Fired
Boiler/Hydronic
Bedrooms: 4
Occupancy: 3
Age: 18

Figure 1: False Pass; Front Elevation

Mold and Moisture Conditions: Minor mold growth appeared on the attic roof sheathing, but little mold appeared in the rest of the home. Plumbing leaks contributed to a wet interior.

Figure 2: Bath vent w/missing flapper

Figure 3: Toilet leaks and wall deterioration

Site Drainage and Rainwater Management: No gutter system was present. The site around the house was relatively flat.

Foundation Conditions: This two-piece modular house rested on piers surrounded by skirting. The skirting was not air-tight to allow ventilation beneath the structure.

Exterior Conditions: The exterior of the home was in good condition except for a bath fan wall cap that was missing its back draft damper (Figure 2).

Figure 4: Dripping water supply lines

Figure 5: blocked and expanded dryer duct

Bathroom: The toilet ran constantly causing considerable condensation on the water supply lines and toilet tank (Figures 3 & 4). The toilet was not fastened securely to the floor. The base of the wall behind the toilet had a hole. Although the tub valve had a slight drip, the unit was in acceptable condition.

Kitchen: The propane stove had a recirculating range hood. One plumbing waste line in the kitchen sink base was wrapped with electrical tape, not an appropriate seal.

Interior Conditions: The dryer duct looked blocked and expanded (Figure 5).

Figure 6: Combustion air intake in attic

Attic: Ventilation was achieved with gable end vents. Combustion air was drawn from the attic (Figure 6). Some minor mold growth appeared on the roof sheathing near the combustion air intake.

Occupant Notes: Two adults, both smokers, and one child lived in the home.

Discussion/Recommendations:

On the Exterior:

1. Replace damaged bath exhaust wall cap.

On the Interior:

1. Repair the toilet, tub, and kitchen sink plumbing.

2. Currently the boiler in the mechanical/laundry/storage room obtains combustion air from the attic. Reconfigure so the combustion air is taken directly from the exterior. Any time the pressure inside the mechanical/laundry/storage room is greater than the attic, warm moist air can freely migrate into the attic space. This is probably the source of moisture that has caused minor mold growth on the attic sheathing.

3. Cut back the drywall behind the toilet and adjacent to the tub up to the undamaged material. Inspect the interior of the wall for damage, repaired if necessary, and close it back up.

4. Replace the range hood recirculating exhaust fan with one that vents to the exterior.

5. Check and repair the dryer exhaust.

Inspection Number: 1-1 KC
Address: King Cove
Model Type: Ranch
Foundation: Piers
Construction: 2 x 6 Wood Frame
Heat Type: Oil Fired Boiler/Hydronic
Bedrooms: 4
Occupancy: Vacant
Age: 18

Figure 1: King Cove; Front elevation

Mold and Moisture Conditions: This vacant unit contained much of the prior owners' personal goods. Frozen plumbing and subsequent flooding of the home occurred in the owners' absence. Mold on the walls resulted from the flooding (Figures 2 & 3). Also mold at the wall to ceiling junction at two-feet on center was present (Figure 4).

Figure 2: Mold on bedroom wall

Figure 4: Mold at wall to ceiling junction

Figure 3: Mold on hallway wall

Site Drainage and Rainwater Management: No gutter system was present. The site around the house was relatively flat.

Foundation Conditions: This two-piece modular house rested on piers surrounded by skirting. The skirting was not air-tight and allowed for ventilation beneath the home. The belly board was in good condition. An abundance of miscellaneous items were beneath the home (Figure 5).

Figure 5: Abundance of clutter in crawl space

Exterior Conditions: The nails holding on the wood siding were working their way out of the wall, leaving the siding loose (Figure 6). The caulking that sealed the joints between the siding and corner boards had separated from the wood (Figure 7).

Bathroom: The bathroom exhaust fan functioned but its bearings were worn out. The bathroom was in satisfactory condition.

Kitchen: The kitchen had an electric stove with a recirculating range hood. The plumbing underneath the kitchen sink was askew and had leaked in the past (Figure 8).

Figure 6: Siding problems

Figure 7: Caulking problems

Figure 8: Skewed kitchen sink drain

Interior Conditions: The interior conditions were rough. Substantial mold from the former flooding event was still present and the homeowner had attempted home improvements by removing a couple bedroom walls. Remove the prior homeowners' possessions before initiating repairs.

Attic: The uninspected attic achieved ventilation with gable end vents.

Occupant Notes: This was a vacant unit.

Discussion/Recommendations:

On the Exterior:

1. The repeated wetting of wood siding had caused the nails to work their way out of the walls and left the siding loose. Large gaps between clapboards allowed wind driven water to enter the walls, penetrate the walls and flooring system, and cause rot in structural members. The nails used to secure the siding were not ring-shank nails. Prior to renailing the siding, remove the lower portions of the siding to below the windows and cover this area with a peel-and-stick type membrane that laps over the metal flashing at the base of the wall. Replace the siding and fasten with ring-shank nails, which should remedy the problem of the siding working itself loose. Resecure all loose siding with ring-shank nails.

2. Instead of drawing combustion air from the attic or crawl space, it is preferable to bring this air from outside. Use a duct that penetrates the mechanical room wall and draws air from the exterior. The duct intake may need to be shielded similar to the boxed-in baffles covering the gable end vents.

On the Interior:

1. Remove personal possessions.

2. Clean moldy drywall. In areas where the paper face of the drywall has been compromised, remove the drywall, inspect interior of wall, repair as needed, and redrywall.

3. Repair the kitchens sink plumbing and cabinet.

4. Replace the range hood recirculating fan with one that vents to the exterior.

Inspection Number: 1-1 SP
Address: St. Paul Island
Model Type: Ranch
Foundation: P.T. Stem wall & Pier
Construction: 2 x 6 Wood Frame
Heat Type: Oil Fired Boiler/Hydronic
Bedrooms: 3
Occupancy: 5
Age: 17

Figure 1: St. Paul Island

Mold and Moisture Conditions: There was moisture damage and mold in the front entry area (Figure 2), at some of the window jambs (Figure 3), at the marriage joint (Figure 4) and in the kitchen sink base cabinet (Figure 5).

Figure 2: Mold at base of a wall in the entry

Figure 3: Mold at window jamb

Site Drainage and Rainwater Management: No guttering system was present and drip lines were evident. The site behind the building drained toward the structure (Figure 6).

Foundation Conditions: The two modular sections of the home joined at the longitudinal building centerline and rested on short stem walls along the perimeter surrounded by skirting and on piers along the centerline. Belly-board sections and insulation had been removed beneath the bathroom. Much clutter was stored in the crawl space.

Figure 4: Mold at marriage joint

Exterior Conditions: The exterior was in good condition.

Bathroom: The bathroom was in good condition. The bathroom fan functioned but the lower intake was constrained by items placed on the cabinet top directly beneath the fan housing (Figure 7).

Figure 5: Mold in sink base

Figure 6: Side and rear of house

Figure 7: Constrained bath fan

Kitchen: The electric stove had a recirculating range hood. A leak was evident beneath the kitchen sink. The plumbing under the sink was taped with electrical tape (Figure 8), not an appropriate seal.

Figure 8: Electrical tape plumbing repairs in kitchen

Interior Conditions: Although mold appeared in the interior, the occupants kept a very neat interior. The mold was due to condensation on under-insulated areas (Figure 9) and plumbing leaks.

Attic: Some discoloration or mold was on portions of the roof sheathing (Figure 10). Approximately 8 to 10 inches of fiberglass insulation was in the attic. Ventilation was achieved with gable end vents.

Occupant Notes: Two adults, both smokers, and three children lived in this home. Two children had asthma, one had allergies, and two had sinus problems since returning from vacation.

Figure 9: Mold in under-insulated and upper outside corner

Figure 10: Discolored roof sheathing

Discussion/Recommendations:

Problems in this house were due to construction deficiencies and plumbing leaks.

On the Exterior:

1. Address site drainage to shed water away from the home rather than beneath it and help keep the soil beneath the home drier than it currently is. This will involve minor site modifications.

2. Problems with the marriage joint are most likely caused by a combination of roof leaks at the ridge that get the ceiling wet and insufficient insulation above the marriage framing. To address problems at the ridge cap, remove the cap, replace or install a gasket, caulk the gasket to the roof, and reinstall the cap. This is described in detail in Section 4.3 on attics. When adding insulation over the marriage joint, inspect other areas along the perimeter of the roof and insulate to a higher degree keeping areas near the top plates warm, especially at the four outside corners.

3. Reinsulate the platform beneath the bathroom and reinstall the belly-board.

4. Clean all cardboard boxes and other exposed organic matter from beneath the home. If this area is to be used for storage, use plastic airtight containers to store goods in (Figure 11).

Figure 11: Missing insulation & clutter in crawl space

On the Interior:

1. Currently the boiler in the mechanical/laundry/storage room obtains combustion air from the attic. Reconfigure the grille at the top of the wall that connects to a screened intake in the attic so that combustion air is taken directly from the exterior. Any time the pressure inside the mechanical/laundry/storage room is greater than the attic, warm moist air can freely migrate into the attic space. This is probably the source of moisture that has caused minor mold growth on the attic sheathing.

2. According to the occupant, this unit is slated to receive new windows. The mold on the jambs surrounding the window may be prevented by insulation so that the drywall does not bear directly on the trimmer stud. A thermal break at this point will keep this area warmer and mold free.

3. Repair the plumbing leaks beneath the kitchen sink and replace any damaged cabinet components.

4. Replace the range hood exhaust fan with a fan that vents to the exterior.

5. Reorient the bath fan cover to draw from the sides rather than the top and bottom.

Inspection Number: 1-2 FP
Address: False Pass
Model Type: Ranch
Foundation: Piers
Construction: 2 x 6 Wood Frame
Heat Type: Oil Fired Boiler/Hydronic
Bedrooms: 4
Occupancy: Vacant
Age: 18

Figure 1: False Pass; Front elevation

Mold and Moisture Conditions: This vacant home just had a partial rehabilitation due to a fire. Leaky kitchen sink plumbing caused damage to the sink base (Figure 2).

Figure 2: Problems w/kitchen sink drains

Site Drainage and Rainwater Management: No gutter system was present. The site around the home was relatively flat.

Foundation Conditions: This two-piece modular home rested on piers surrounded by skirting. The skirting was not air-tight and allowed for ventilation beneath the home. The belly-board was in good condition.

Figure 3: Damage to kitchen sink base cabinet

Exterior Conditions: The exterior of home was in good condition.

Bathroom: The bathroom was in good condition. The exhaust fan was not evaluated because the utilities were off.

Kitchen: The electric stove had a recirculating range hood. The plumbing waste lines in the kitchen sink base were repaired with electrical tape, no-hub connectors, and nylon string (Figure 2). Plumbing leaks damaged the base cabinet (Figure 3).

Interior Conditions: Slight mold was at the bedrooms wall to ceiling junctions, but otherwise the unit was in good condition.

Attic: The attic was not inspected. Ventilation was achieved with gable end vents.

Occupant Notes: This was a vacant unit.

Discussion/Recommendations:

On the Interior:

1. Currently the boiler in the mechanical/laundry/storage room obtains combustion air from the attic. Reconfigure to take combustion air directly from the exterior. Any time the pressure inside the mechanical/laundry/storage room is greater than

the attic, warm moist air can freely migrate into the attic space. This is probably the source of moisture that has caused minor mold growth on the attic sheathing.

2. The kitchens sink plumbing and cabinet need to be repaired.

3. Replace the range hood exhaust fan with one that vents to the exterior.

Inspection Number: 1-2 KC
Address: King Cove
Model Type: Ranch
Foundation: Piers
Construction: 2 x 6 Wood Frame
Heat Type: Forced air
Bedrooms: 3
Occupancy: 6
Age: 25

Figure 1: King Cove; Front elevation

Mold and Moisture Conditions: Several areas had mold in this home, primarily at the base of walls (Figure 2), at outside corners (Figures 3), at the wall to ceiling junction (Figure 4), and in closets (Figure 5).

Figure 3: Mold at base of wall opposite entry wall

Figure 2: Mold at base of wall in living room

Site Drainage and Rainwater Management: No gutter system was present. The site around the house was relatively flat.

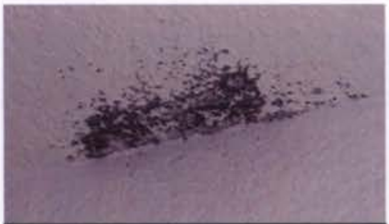

Figure 4: Mold at wall to ceiling junction

Foundation Conditions: This was a two-piece modular house that rested on piers. The piers were surrounded by skirting. The skirting was not air-tight and allowed for ventilation beneath the structure.

Exterior Conditions: The nails fastening the wood siding to the wall were working their way out of the wall, leaving the siding loose (Figure 6). Metal flashing had been installed beneath the siding at the base of the wall, but was still allowing significant air and water infiltration during incidents of high wind (Figure 7).

Figure 5: Mold in the corner of the closet

Figure 6: Loose siding

The front porch was recessed, acting as a water collector during rainy times. This resulted in deterioration of the exterior wall at floor level and caused damage to the wall and floor in the living room.

Bathroom: The bathroom was in good condition except that the bath fan cover was missing and the fan motor itself was dirty (Figure 8).

Figure 7: Air leaks around loose siding

Figure 8: Dirty bath fan

Kitchen: The kitchen had an electric stove and a recirculating range hood. There were no obvious plumbing problems.

Figure 9: Missing flue cap

Mechanical: Due to a freeze-up of the hydronic piping, the owners replaced the boiler system with a forced air unit in 1989. The flue was missing its cap (Figure 9) which could allow water into the interior. The exterior of the flue inside the mechanical room showed evidence of liquid water running down it, from water entering in or around the flue at the roof and/or due to condensation of flue gases (Figure 10). The hot water heater showed signs of flame roll-out at the inspection port (Figure 11). Combustion air was provided by a register in the floor connected to the crawlspace (Figure 12).

Figure 10: Rusty boiler flue

Figure 11: HWH flame roll-out

Figure 12: Combustion air intake

Interior Conditions: Water infiltration had caused the subfloor in the dining area to become soft and structurally unsound (Figure 13).

Figure 13: Rotting subfloor

Attic: The attic had approximately 8 to 10 inches of fiberglass insulation between trusses, but the marriage joint was not insulated (Figure 14). Ventilation was achieved with gable end vents.

Occupant Notes: Ttwo adults and four children lived in this home.

Discussion/Recommendations:

On the Exterior:

Figure 14: Marriage joint in attic

1. The repeated wetting of wood siding had caused the nails to work their way out of the walls and left the siding loose. Large gaps between clapboards allowed wind driven water to enter the walls and penetrate the walls and flooring system causing rot in structural members. The nails used to secure the siding were not ring-shank nails. Prior to renailing the siding, remove the lower portions of the siding to below the windows and cover this area with a peel-and-stick type membrane that laps over the metal flashing at the base of the wall. Replace and fasten with ring-shank nails that should mitigate the problem of the siding working itself loose. Resecure all loose siding with ring-shank nails.

2. Replace the existing flue with an appropriately sized flue for the HWH.

3. Build a small covered entry in front of the existing entry to keep water out. Close the existing area in so that it could serve as a vestibule.

4. Instead of drawing combustion air from the attic or crawl space, it is preferable to bring this air from outside. Use a duct that penetrates the mechanical room wall and draws air from the exterior. The duct intake may need to be shielded similar to the boxed-in baffles covering the gable end vents.

On the Interior:

1. Remove and replace the dining area linoleum and all damaged subfloor with new materials. DO NOT do this before resolving the exterior siding issues.

2. Clean moldy drywall with soap and water and in areas where the paper face of the drywall has been compromised, remove the drywall, inspect the interior of the wall, repair as necessary, and redrywall.

3. Increase insulation in the attic, particularly along the perimeter and over the marriage joint framing.

4. Clean the bathroom fan and install a cover.

5. Replace the range hood exhaust fan with one that vents to the exterior.

Inspection Number: 1-2 SP
Address: 610
Model Type: Ranch
Foundation: P.T. Stem wall & Pier
Construction: 2 x 6 Wood Frame
Heat Type: Oil Fired Boiler/Hydronic
Bedrooms: 3
Occupancy: 3
Age: 17

Figure 1: St. Paul - 610; Front Elevation

Mold and Moisture Conditions: Occupants reported seasonal mold and moisture problems around the windows.

Figure 2: Rear Elevation and piers

Figure 3: Wet crawl space perimeter

Site Drainage and Rainwater Management: No gutter system was present. The site at the front of the home drained toward the home (Figure 1).

Foundation Conditions: The two modular sections of the home joined at the longitudinal building centerline and rested on short stem walls along the perimeter and on piers along the centerline (Figure 2). Skirting surrounded the wet crawl space perimeter soil (Figure 3).

Figure 4: Dryer vent above crawl space vent

Exterior Conditions: The home exterior was in good condition except the boiler flue cap was missing. The dryer vented directly above the crawl space vent (Figure 4).

Bathroom: The bathroom was in good condition. The bath fan functioned inefficiently due to the buildup of lint and dust on the interior of the unit (Figure 5).

Figure 5: Dirty bath fan

Kitchen: The electric stove had a recirculating range hood.

Interior Conditions: Interior conditions were good.

Attic: There was some discoloration or mold on portions of the roof sheathing. There was approximately 8 to 10 inches of fiberglass insulation in the attic. Ventilation was achieved with gable end vents.

Occupant Notes: Two adults and one child lived in the home. The child had allergies.

Discussion/Recommendations:

Problems in this house were due to construction deficiencies and plumbing leaks.

On the Exterior:

1. Modify the site drainage to shed water away from the home rather than beneath it to keep the soil beneath the building drier than it currently is. A drain tile along the front of the home that captures the water and then diverts it around to the backside of the home would help.

2. Reinstall a cap on the boiler flue. Currently water can enter the flue and drain into the mechanical system shortening its lifespan.

3. Although gutters may be problematic in this climate due to wind and ice buildup, gutters may be a good idea on the rear of this home. Currently the roof sheds onto a big deck on the back of the home, undoubtedly splashing it back onto the siding exposing it to additional water. Capture and control the water above the deck.

4. Clean all cardboard boxes and other exposed organic matter from beneath the home. If using this area for storage, use plastic airtight containers to store goods in.

On the Interior:

1. The boiler in the mechanical/laundry/storage room obtained combustion air from the attic. The grill at the top of the wall connected to a screened intake in the attic (Figure 6). Reconfigure it so that combustion air is taken directly from the exterior. Any time the pressure inside the mechanical/laundry/storage room is greater than in the attic, warm moist air can freely migrate into the attic space. This is probably the source of moisture that has caused minor mold growth on the attic sheathing.

Figure 6: Combustion air intake

2. Replace the range hood exhaust fan with a fan that vents to the exterior.

Inspection Number: 1-3 KC
Address: King Cove
Model Type: Ranch
Foundation: Piers
Construction: 2 x 6 Wood Frame
Heat Type: Oil Fired Boiler/ Hydronic
Bedrooms: 3
Occupancy: 4
Age: 25

Figure 1: King Cove; Front elevation

Mold and Moisture Conditions: Mold was in the bathroom, beneath the kitchen sink, and on the underside of the belly board.

Figure 2: Rotting skirting

Figure 3: Wet belly board beneath mechanical room and bath

Site Drainage and Rainwater Management: No gutter system was present. The grade in the front yard sloped toward the home and in the back yard sloped away from the home.

Foundation Conditions: This two-piece modular house rested on piers, surrounded by skirting. The skirting was not air-tight and allowed for ventilation beneath the structure.

Figure 4: Tub Surround deterioration

Figure 5: Poor repair of the vanity waste pipes

Exterior Conditions: Some siding and skirting toward the base of the home was rotting from water saturation (Figure 2), but otherwise, the walls were in fairly good condition. The underside, or belly board of the home was wet beneath the bathroom and mechanical room (Figure 3). Insulation was missing and portions of the belly board were missing.

Bathroom: Seams in the bathtub surround were dirty and had some mold growth (Figure 4). The bathroom fan was unplugged and did not function. The vanity waste pipes were held together with a hose clamp (Figure 5). The enamel coating on the vanity sink had been chipped away in several areas.

Figure 6: Kitchen sink waste leak

Kitchen: The kitchen had a gas stove and a recirculating range hood. The kitchen sink waste piping appeared to have a leak. There was a wet paper towel on the cabinet base and slight mold growth on the wall at the back of the cabinet (Figure 6).

Mechanical: The dryer wall cap was stuck open (Figure 7). The boiler provided hot water for both the baseboard convective heaters and the domestic hot water system. The hot water tank was leaking. The floor in the mechanical room was wet and the subfloor was in poor condition (Figure 8).

Figure 7: Open dryer wall cap

Interior Conditions: Several areas within the home were in need of repair. Left unrepaired, several of the problems will undoubtedly result in mold growth and structural deterioration.

Attic: The attic was not inspected. Ventilation was achieved with gable end vents.

Occupant Notes: Two adults and two children lived in this home.

Figure 8: Wet mechanical room floor

Discussion/Recommendations:

On the Exterior:

1. The repeated wetting of wood siding had caused the nails to work their way out of the walls and left the siding loose. Large gaps between clapboards allowed wind driven water to enter the walls and penetrate the walls and flooring system causing rot in structural members. The nails used to secure the siding were not ring-shank nails. Prior to renailing the siding, remove the lower portions of the siding to below the windows. Cover this area with a peel-and-stick type membrane that laps over the metal flashing at the base of the wall. Remove and replace the siding, fastening with ring-shank nails to mitigate the problem of the siding working itself loose. Resecure all loose siding with ring-shank nails.

2. Build a small covered entry in front of the existing entry to keep water out of the existing entry area. The existing area could then be closed in so that it could serve as a vestibule.

3. Instead of drawing combustion air from the attic or crawl space, it is preferable to bring this air from outside. Use a duct that penetrates the mechanical room wall and draws air from the exterior. The duct intake may need to be shielded similar to the boxed-in baffles covering the gable end vents.

4. Replace dryer vent cap.

On the Interior:

1. The mechanical room should receive immediate attention. The floor was saturated with moisture and deteriorated. Mechanical equipment will need to be removed for the floor to be repaired. Leaks will hopefully be eliminated during reinstallation.

2. Clean moldy drywall with soap and water. In areas where the paper face of the drywall has been compromised, remove the drywall, inspect the interior of the wall, repair as necessary, and redrywall.

3. Inspect and repair leaky plumbing.

4. Replace the bathroom fan.

5. Replace the range hood exhaust fan with one that vents to the exterior.

Inspection Number: 1-3 SP
Address: St. Paul Island
Model Type: Ranch
Foundation: P.T. Stem wall & Pier
Construction: 2 x 6 Wood Frame
Heat Type: Oil Fired Boiler/Hydronic
Bedrooms: 3
Occupancy: 3
Age: 17

Figure 1: St. Paul Island; Front Elevation

Mold and Moisture Conditions: Occupants reported moisture at the marriage joint every time it rained. Windows exhibited heavy condensation, mold and/or dirt on the frames.

Site Drainage and Rainwater Management: No gutter system was present (Figure 2). The site surrounding the home was fairly flat.

Figure 2: Rear elevation and no gutter system

Foundation Conditions: The two modular sections of the home joined at the longitudinal building centerline. The modular sections rested on short stem walls along the perimeter and on piers along the centerline. Skirting surrounded the perimeter. The soil surrounding the perimeter was wet and the clutter in the crawl space had mold on it (Figures 3 & 4).

Figure 3: Wet crawl space

Figure 4: Moldy clutter on crawl space floor

Exterior Conditions: The exterior of the home appeared in good condition.

Bathroom: The base of the wall behind the toilet and next to the tub was moldy and deteriorated (Figure 5 & 6). The bath fan functioned well.

Figure 5: Mold behind toilet

Figure 6: Wall deterioration next to tub

Kitchen: The sink base cabinet had been compromised and had mold on the interior of the cabinet due to plumbing leaks. One of the waste pipes was fixed with duct tape (Figure 7), not an appropriate leak seal. The electric stove had a recirculating range hood.

Figure 7: Duct tape plumbing repair

Interior Conditions: Distinct ghosting, darkening of the drywall, was at the studs on some bedroom walls (Figure 8). Some windows had heavy condensation on the glass surface and mold and/or dirt on the window frames (Figure 9).

Figure 8: Ghosting on each stud

Attic: Approximately 8 to 10 inches of fiberglass insulation was in the attic. Ventilation was achieved with gable end vents. The attic hatch was a piece of drywall with fiberglass insulation attached to the top of it. The hatch did not seal tightly as was evidenced by the discoloration of the fiberglass, which acted as a filter when air from the home escaped around the perimeter of the hatch and leaked into the attic (Figure 10). The sheathing above the hatch had minor mold growth on its surface.

Figure 9: Condensation on window

Figure 10: Discolored insulation on top of attic hatch

Occupant Notes: Three adults lived in this home and one was diabetic.

Discussion/Recommendations:

On the Exterior:

1. Address problems with the marriage joint, caused by a combination of roof leaks at the ridge that get the ceiling wet and insufficient insulation above the marriage framing. To address problems at the ridge cap, remove the cap, replace or install a gasket, caulk the gasket to the roof, and reinstall the cap. This is described in detail in Section 4.3 on attics. When adding insulation over the marriage joint, other areas along the perimeter of the roof can also be inspected and be insulated to a higher degree to keep areas near the top plates warm, especially at the four outside corners of the building.

Figure 11: Missing insulation & clutter in crawl space

2. Clean all cardboard boxes and other exposed organic matter from beneath the home. Use plastic airtight containers to store goods in the crawl space (Figure 11).

3. Install a crawl space vapor barrier over the wet soil, carefully sealing it to the skirting.

On the Interior:

1. Currently the boiler in the mechanical/laundry/storage room obtains combustion air from the attic. Reconfigure the grille at the top of the wall that connects to a screened intake in the attic so that combustion air is taken directly from the exterior. Any time the pressure inside the mechanical/laundry/storage room is greater than the attic, warm moist air can freely migrate into the attic space. This is probably the source of moisture that has caused minor mold growth on the attic sheathing.

2. Replace the range hood exhaust fan with a fan that vents to the exterior.

3. Repair or replace the kitchen sink base and fix the plumbing.

4. The extent of repairs at the base of the wall behind the toilet will only be known once the baseboard is removed to expose the drywall behind it. Remove and replace the drywall in this area as needed.

5. The stud ghosting indicates areas that could benefit from better insulating. If in the future this home is re-sided, use a continuous layer of rigid insulation prior to the installation of the siding, creating a thermal break and eliminating ghosting on the interior.

6. Heavy condensation on the windows indicates high humidity on the interior of the home. Running a dehumidifier during heavy condensation would help if not solve this problem.

Inspection Number: 1-4 KC
Address: King Cove
Model Type: Ranch
Foundation: Piers
Construction: 2 x 6 Wood Frame
Heat Type: Boiler / Forced-Air
Bedrooms: 3
Occupancy: 1
Age: 25

Figure 1: King Cove; Front Elevation

Mold and Moisture Conditions: Several areas in this home had either mold or dry-rot. Siding, portions of the roof structure, and interior spaces had deterioration due to moisture (Figure 2).


Figure 2: Rotted siding and windows


Figure 3: Underside of floor system

Site Drainage and Rainwater Management: The site surrounding the home was flat. There were no gutters.

Foundation Conditions: The home was set on piers surrounded by skirting. On the long sides of the house, the skirting was held back from the plane of the wall. It was not clear how the floor system was insulated. The underside of the house was inaccessible (Figure 3).


Figure 4: Rotted fascia board


Figure 5: Deterioration around tub

Exterior Conditions: The exterior of the house was in poor condition. The siding was badly deteriorated, the windows needed replacement, and portions of the fascia board were missing or rotted (Figure 4).

Bathroom: There was deterioration of the plywood wall surfaces surrounding the tub (Figure 5). There was a slight amount of mold around the base of the toilet. There was no bath fan.

Kitchen: There was an electric stove, but the range hood was missing. The kitchen sink did not appear to have any leaks.

Mechanical: The furnace, hot water heater, and washing machine were located in the kitchen and living room (Figures 6 & 7). Plumbing adjacent to the HWH had leaks (Figure 8). The furnace flue did not have a cap, but the HWH flue did. The fuel supply tank leaked (Figure 9).

Figure 6: Furnace in living room

Figure 7: HWH in Kitchen

Figure 8: Leaky plumbing

Figure 10: Panel rot at base of wall

Interior Conditions: The resident mentioned that flooring adjacent to the exterior wall beneath a window was rotten. Carpeting was taped over the area so that it could not be visually inspected; however the flooring was soft in that area. Panel rot was at the base of a wall (Figure 10). Ceiling tiles were loose and there was evidence of former leaks towards the perimeter of the building (Figure 11), the bathroom needed remodeling, the side-door door jamb was rotten, the electrical panel cover was missing and most of the windows were in bad condition.

Figure 9: Leaky fuel storage tank

Figure 11: Water stains on ceiling

Attic: The attic was not inspected. The gable-end vents had a shield over them to keep blowing snow and rain out of the attic, however the shields were completely enclosed causing the attic to be unventilated (Figure 12).

Figure 12: Sealed gable end vent

Occupant Notes: There was one permanent occupant and her son stayed with her during fishing season.

Discussion/Recommendations:

On the Exterior:

The roof, siding and windows all need to attention:

1. Repair the fascia boards and replace where missing.

2. Replace the shingles. Due to the moss on the roof, the shingles need to be stripped. Inspect and repair the deck as necessary before reinstalling felt paper and shingles.

3. Strip the siding from the wall and inspect the interior of the wall for damage and repair as necessary. Install rigid insulation over the studs to eliminate any thermal bridges. An air-barrier should be installed over the rigid insulation and then the siding over that.

4. All windows should be replaced at the same time that the siding is replaced.

5. Both exterior doors and jambs should be replaced during the residing process.

6. Flue caps should be installed on all flues.

7. Gable end vents should be opened up to reestablish venting of the attic space.

8. The home must have ducts below the floor system for air distribution. These ducts and the floor system should be inspected to insure their integrity. The skirting should be relatively air-tight to minimize heat loss from the ductwork. The floor system should be well insulated.

9. Repair leaking fuel-oil supply (Figure 12).

On the Interior:

1. The furnace, HWH and washing machine should be relocated to the bedroom adjacent to the living room turning this bedroom into a mechanical room. This will require minor reducting of the furnace supply duct and replumbing the HWH and washing machine.

2. The bathroom should be remodeled with a new tub surround and a bath fan should be installed. The fan should be ducted to the exterior either through the wall or out through the roof.

3. A new range hood exhaust should be installed. The penetration through the wall already exists.

4. The subfloor should be cut out from areas where it is soft and be replaced.

5. The attic should be inspected and more than likely, additional insulation should be installed, particularly along the perimeter of the house.

6. Damaged and stained ceiling tiles should be removed and replaced.

7. Remove damaged wall paneling and replace.

Inspection Number: 1-4 SP
Address: St. Paul Island
Model Type: Ranch
Foundation: P.T. Stem wall & Pier
Construction: 2 x 6 Wood Frame
Heat Type: Oil Fired Boiler/Hydronic
Bedrooms: 3
Occupancy: 5
Age: 17


Figure 1: St, Paul Island; Front elevation sloped away from home


Figure 2: Flat rear elevation


Figure 3: Area between tub and toilet


Figure 4: Leaky tub valve


Figure 5: Nonfunctional bath fan

Figure 6: Deterioration above tub

Mold and Moisture Conditions: Several rooms throughout the home had mold. The bath and kitchen had plumbing leaks contributing to a wet interior.

Site Drainage and Rainwater Management: No gutter system was present. The site at the front of the house was sloped away from the home (Figure 1), and in the rear it was flat (Figure 2).

Foundation Conditions: The siding of this home went all the way to the ground. The crawl space was not accessed.

Exterior Conditions: The exterior of the home appeared in good condition except for a broken ventilation wall caps and a broken window.

Bathroom: The bath was in need of attention. There was deterioration of the wall next to the tub and behind the toilet (Figure 3). The tub faucet had a constant stream of water coming out of it (Figure 4) and the faucet dripped. The bath fan was inoperable (Figure 5) and the drywall above the tub showed signs of deterioration (Figure 6).

Kitchen: The electric stove had what appeared to be a range hood that was ducted to the outside, yet when looking in the cabinet above the unit, there was a hole into the wall where the fan should have been ducted to (Figure 7). The exhaust fan was nonfunctional. The kitchen sink base was in bad condition. Continual plumbing leaks have caused considerable damage to the cabinet (Figures 8 & 9). There was damage to an inside corner wall where the wall cabinets did not meet (Figure 10). On the opposite side of this wall was the tub and shower enclosure.

Figure 7: Nonfunctional range hood, note duct in cabinet above

Figure 8: Plumbing repairs

Figure 9: Badly deteriorated kitchen sink base

Figure 10: Kitchen wall opposite bath

Interior Conditions: Although not obvious, the dryer duct must have had a leak as evidenced by the lint behind the unit (Figure 11). There was condensation on some of the windows and the window jambs had a slight amount of mold growth (Figure 12). Interior conditions were rough, especially in the bath and kitchen. Lifestyle contributed to the problems.

Attic: Ventilation was achieved with gable end vents. The attic itself was not accessed.

Occupant Notes: Two adults and three children lived in the home. One of the children had asthma.

Figure 11: Leaky drier vent

Figure 12: Window condensation and mold on jamb

Discussion/Recommendations:

On the Exterior:

1. Replace damaged exhaust wall caps.
2. Repair broken window.
3. Access the crawl space and install a vapor barrier, if not present.

4. Access the attic to confirm that the bath fan is properly connected to the wall exhaust cap and that there is a sufficient amount of insulation in the attic.

On the Interior:

1. Replace bath exhaust fan with a high quality fan and duct to the exterior.

2. Repair the tub, vanity and kitchen sink plumbing.

3. Remove and replace kitchen sink base cabinet.

4. Replace the range hood exhaust fan and properly duct it to the exterior.

5. Check and repair the dryer exhaust.

6. Remove, inspect for damage, repair, and replace the drywall behind the toilet and adjacent to the tub.

7. Clean the window jambs, then lightly sand and repaint.